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OFFICE OF NAVAL INTELLIGENCE, 11

GENERAL INFORMATION SERIES, NO. IX.

INFORMATION FROM ABROAD.

A YEAR'S NAVAL PROGRESS.

ANNUAL OF THE OFFICE OF NAVAL INTELLIGENCE.

JUNE, 1890.

NAVY DEPARTMENT,
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INTRODUCTION.

The publication of the annual volume of the Office of Naval Intelligence, of which the present issue is No. IX of the general Information Series, is intended to bring to the attention of naval officers and others interested in naval matters the year's progress in naval development abroad, and to preserve a record of it in permanent form for reference. The volume is continuous with the series, and frequent reference to the preceding numbers will be found in it. The preservation of the whole series is therefore desirable, as the office can no longer furnish copies of back numbers.

It should be borne in mind that this volume is intended to exhibit the progress of foreign nations rather than our own; that the information conveyed in the notes is compiled from professional papers and journals, and that almost all of it has already appeared in print. It has been thought best this year to give the *Notes* the most prominent place in the volume.

Chapter V presents a study of the naval manœuvres of last summer, and Chapter VI, the very valuable paper by Mr. W. H. White, F. R. S., on the same subject, follows it naturally.

Chapters VII and VIII may be of value in view of the probability of a general re-organization of the personnel of the United States Navy.

Chapter X is presented as a sequel to the article in last year's number on the same subject.

C. H. DAVIS,
Commander, Chief Intelligence Officer.

NAVY DEPARTMENT, *June* 1, 1890.

I.

NOTES ON SHIPS AND TORPEDO BOATS.

UNITED STATES.

The naval appropriation bill for the fiscal year ending June 30, 1891, provides $8,120,000 for "Increase of the Navy," and authorizes the construction of the following vessels:

Three sea going coast-line battle ships designed to carry the heaviest armor and most powerful ordnance upon a displacement of about 8,500 tons, with a coal endurance of about 5,000 knots on the total coal capacity at the most economical rate of speed, and to have the highest practicable speed for vessels of their class, to cost, exclusive of armament and of any premiums that may be paid for increased speed, not exceeding $4,000,000 each; one protected cruiser of about 7,300 tons displacement, at a cost, exclusive of armament, not to exceed $2,750,000, to have a maximum speed of not less than 20 knots; one swift torpedo cruiser of about 750 tons displacement, at a cost, exclusive of armament, not to exceed $350,000, to have a maximum speed of not less than 23 knots; and one torpedo-boat at a cost not to exceed $125,000.

VESSELS PROPOSED OR LAID DOWN.

FIRST-CLASS ARMORED CRUISER (No. 2.)

The displacement of this vessel (page 329, GENERAL INFORMATION SERIES, No. VIII) has been increased from 7,500 to 8,150 tons. The new plans are completed, and a circular issued by the Department for the guidance of bidders has the following principal requirements:

Battery: Six 8-inch B. L., 35 calibre; twelve 4-inch R. F. G.;* twelve R. F. G. of smaller calibre; four 37-millimetre R. C.,† and four machine guns.

The hull is to be protected by a vertical belt 3⅞-inches thick over the machinery space, and by a steel protective deck, 2.5 to 6 inches thick, which extends from stem to stern. Within the armor belt and above the protective deck, a coffer-dam 3½ feet wide, for water-excluding material, is to extend the whole length of the vessel.

---

* Rapid-fire guns.

† Revolving cannon.

The 8-inch guns in the barbettes are to be protected by armor of not less than 10 inches around the carriages, platforms and loading positions, and by a suitable heavy shield of not less than 7 inches over the guns.

The ammunition hoists and spaces below the heavy gun mounts will have cone-shaped armor 5 inches thick. The 4-inch guns will be protected by segmental shields of not less than 4 inches: Conning tower, 7½ inches.

Engines to be of the vertical triple expansion type, four in number, two on each shaft and in two compartments. The forward engines to be readily uncoupled from the after ones for cruising at low speeds.

The estimated speed is 20 knots with 16,000 I. H. P.; the total coal capacity must not be less than 1,150 tons, of which at least 500 tons is to be carried at the normal load displacement.

The bids for the construction of this vessel will be opened on June 10, 1890, and she is to be completed by January 1, 1893.

FIRST-CLASS PROTECTED CRUISER (No. 6.)

This vessel (page 329, No. VIII), for which sealed proposals have been invited by the Navy Department under advertisement dated April 8, 1890, is a twin-screw protected cruiser of about 5,500 tons displacement. Proposals will be opened June 10, 1890.

The following are the principal requirements.

Armament: Two 8-inch B. L. in barbette turrets 4 inches thick, and ten 4-inch R. F. G. protected by 4-inch segmental shields. The secondary battery consists of eight 6-pounders, six 3-pounders, and fourteen machine guns. In each of the lower military tops are mounted a 37-millimetre Maxim gun, and a 1-pounder Hotchkiss R. F. G.

The torpedo outfit consists of six launching tubes for automobile torpedoes, one fixed at the stem, one at the stern, and two training tubes on each broadside.

Two triple-expansion engines are to give 13,500 I. H. P. and about 20¼ knots speed. (Contract requires at least 20 knots). They are intended to be driven 128 revolutions with maximum power. The diameters of the cylinders are 42, 59, and 92 inches, by 42-inch stroke.

The boilers are six in number, two single-ended and four double-ended, the larger ones having eight furnaces and the smaller four. They are 15 feet 3 inches in diameter, cylindrical, and are intended to carry 160 pounds pressure per square inch.

With the full coal supply, 1,300 tons, at maximum speed the steaming radius will be 2,192 knots, and at a 10-knot cruising speed, 13,000 knots, with an endurance of about fifty-five days.

The protective deck is 4.75 inches thick on the slopes and 2 inches on the flat over the machinery space, and 3 inches on the slopes and 2 inches on the flat forward and abaft it.

A belt of water excluding material 33 inches thick, in coffer-dams extending 4 feet above and 4 feet, 5 inches below the load-water line, extends the whole length of the vessel. Coal protection is afforded the machinery by the location of the bunkers along the side below the protective deck, and above that deck for the length of the boiler and engine space. Armored ammunition tubes are 3 inches thick, and conning towers 5 inches.

The hull plating is increased in thickness in the wake of all machine guns.

Principal dimensions: Length on mean load water line, 330 feet; breadth, extreme, 53 feet; draught of water, mean, 21 feet 6 inches; displacement on normal draught, 5,500 tons.

The ship is to be completed by January 1, 1893.

SECOND-CLASS PROTECTED CRUISERS (Nos. 7 AND 8).

The bids for these vessels (page 329, No. VIII) being too high, the Department decided to build them in Government yards. The keel of No. 7 was laid at the New York navy-yard on January 29, 1890, and that of No. 8 at the Norfolk navy-yard, December 19, 1889.

CRUISERS Nos. 9, 10, AND 11.

The original requirements for these vessels (page 330, No. VIII) were too high and it was found necessary to reduce them before satisfactory bids could be obtained. The contracts were finally given, Nos. 9 and 10 to the Columbian Iron Works, of Baltimore, and No. 11 to Mr. Harrison Loring, of Boston.

The contract price of Nos. 9 and 10 is $1,225,000, and of No. 11, $674,000.

The required speed, 17 knots, is to be maintained successfully for four consecutive hours; and a premium of $25,000 is offered for every quarter knot in excess.

The vessels are to be completed in two and a half years from date of contract—November, 1889.

The keels of Nos. 9 and 10 were laid on April 19, 1890.

STEEL PRACTICE VESSEL.

Proposals were invited for the construction of this vessel (page 330, No. VIII) on November 19, 1889, but no satisfactory bids being obtained a new circular was issued on April 8, 1890, inviting proposals, which are to be opened on the 10th of June.

She is to be armed with four 4-inch, two 6-pounder, two 3-pounder, and one 1-pounder, R. F. G.; and one 37-millimetre R. C. and one Gatling.

Two triple-expansion engines are to give 1,300 I. H. P. and 12 knots speed during four consecutive hours.

To be completed in two years from date of contract.

TWO STEEL GUN VESSELS (Nos. 5 AND 6).

On January 22, 1890, bids for the construction of these vessels (page 331, No. VIII) were opened at the Navy Department, and the Bath Iron Works, of Bath, Me., secured the contracts, agreeing to build both of them for $637,000, and to complete them in two years.

Some of the requirements are that they shall carry batteries of eight 4-inch R. F. G., five R. F. G. of smaller calibre and two Gatlings; have engines of 1,600 horse-power, and make an average speed of 13 knots during four consecutive hours.

Partial protection is to be afforded by a steel deck .37 of an inch thick, and by a belt of water excluding material.

Dimensions: Length, 190 feet; beam, 32 feet; mean draught, 12 feet; displacement, 1,050 tons.

MONTEREY.

This vessel was formerly known as Coast Defense Vessel No. 1 (page 331, No. VIII). Her battery has been changed, and it is now intended that she shall carry two 12-inch B. L. in the forward barbette; two 10-inch in the after barbette, six 6-pounders, four 3-pounders, and two 1-pounder R. F. G., and four Maxim guns.

Steel armor will probably be distributed as follows: a complete belt 13 inches thick; 14 inches on forward barbette; 11½ inches on the after one, and 8-inch sloping shields over the heavy guns.

VESSELS BUILDING.

Work is progressing on the battle-ship *Texas* at the Norfolk navy-yard, and on the armored cruiser *Maine*, at New York (pages 298, No. VII, and 332, No. VIII). It is expected that the former will be ready for launching by May, 1891, and the latter during the coming summer.

Under the act approved August 3, 1886, authorizing the completion of the double-turreted monitors *Puritan*, *Amphitrite*, *Monadnock*, and *Terror*, proposals have been received and contracts made during the year for the materials required to complete the last three.

Plans for the proposed change of the *Puritan* having been approved by the Bureau of Construction, they were submitted for examination to the Board on Construction, and after receiving a favorable report were approved by the Department, and the work was ordered on June 26, 1889.

The description of these alterations given on page 332, No. VIII, is correct except that the vessels are to have 14-inch barbette armor instead of 12-inch, as there stated.

VESSELS LAUNCHED.

PHILADELPHIA.

A protected cruiser of 4,324 tons displacement, described on page 299, No. VII, was launched at the ship-yard of Messrs. William Cramp & Sons, at Philadelphia, on September 7, 1889.

SAN FRANCISCO—NEWARK.

Protected cruisers of 4,083 tons (pages 239, No. VI, and 299, No. VII). The former was launched at the Union Iron Works, San Francisco, October 26, 1889, and the latter by Messrs. Cramp & Sons, at Philadelphia, on March 19, 1890.

CONCORD.

Partially protected cruiser of 1,703 tons (page 300, No. VII) was launched at the Delaware River Iron Works, Chester, Pa., on March 8, 1890.

STEAM TRIALS.

BALTIMORE.

First-class protected cruiser of 4,392 tons, described on page 237, No. VI, had her official full power trials on September 14, 1889.

The distance run in four hours was 78.3 knots, giving an average speed of 19.57. The maximum speed for one hour was 20.2 knots: Average I. H. P., 8,978.

This highest speed was made in the third hour, after the boilers and engines had been driven for two hours under forced draft: and at the end of the four-hour trial the vessel was in condition to undertake another such run without further preparation.

The speed records were obtained by the patent log, corrected by bearings on shore, before and after the run. The maximum power and speed (taken for fifteen minutes) were 9,548 I. H. P. and 20.8 knots.

The contractors not being satisfied with the results of the above trial, and believing that they could do better on another, obtained the consent of the Navy Department, and the new trial took place on November 15.

Some changes were made in the machinery between the two trials, the most important being the increase of the pitch of the propellers to about 21.5 feet and an overhauling of valves and air pumps.

For the first hour and a half the wind varied in force from 3 to 5, with smooth and moderate sea; but for the remainder of the time the wind's force was 7 and the sea rough; the wind was abeam except for the last quarter, when it was ahead.

The performance of the machinery was admirable except that the L. P. crank-pin of port engine was for a time so hot that it seemed to threaten any further continuance of the trial.

Average performance:		
Aggregate I. H. P. of all machinery		10.064
Speed (mean for four hours)	knots	20.096
Maximum performance:		
I. H. P. of all machinery		10.725
Speed	knots	20.6

CHARLESTON.

This vessel, a protected cruiser of 3,730 tons displacement (pages 238, No. VI, and 298, No. VII), was given her contract trials on August 21, 1889. Some changes had been made in her machinery and the pitch of her propeller blades had been reduced one foot since her unsuccessful trial in May, 1889.

On August 23, the machinery was run for six hours at full power under forced draft; the last four hours being taken as the period of the official trial.

The machinery and boilers performed perfectly throughout.

Data of trial:

Distance run in six hours by log	knots	109
Average	do	18.166
Distance run last four hours by log	do	72.75
Average	do	18.187
Maximum speed by log	do	18.75
Average speed for four hours for periods during which indicator cards were taken	knots	18.205
Average I. H. P. during four-hour trial		6,666.16
Maximum I. H. P.		6,943.45

PETREL.

This gun vessel is described on page 241, No. VI, as Gun-boat No. 2.

The contractors' forced-draft trial took place in Chesapeake Bay on August 19, with the following mean results for four hours: Speed, 11.79 knots, I. H. P., 1,095.15.

The contract power for this vessel was 1,100, and the highest developed during the trial was 1,513. The maximum speed obtained was 13.7 knots. Although the contract power, 1,100 I. H. P., was not maintained for the four hours of forced draft, yet the performance was sufficiently satisfactory to warrant the vessel's acceptance.

VESUVIUS.

Dynamite gun cruiser (page 300, No. VII and 332 No. VIII) had a trial on May 10, in Delaware Bay. A straight run was made for twenty minutes, during which the engines developed over 3,700 I. H. P., and the estimated speed was 21.75 knots.

She has been accepted by the Department.

CUSHING.

This boat (Torpedo-boat No. 1, page 407, No. VII) was launched by the Herreshoff Manufacturing Company at Bristol, R. I., on January 23, 1890.

A trial took place in Narragansett Bay March 24 and 25, 1890. A speed of 22.52 knots was maintained for three hours, and the Department accepted her.

ENGLAND.

All of the ships that were ordered and commenced before 1889–'90 will be completed during 1890–'91, with the exception of the *Blake* and *Blenheim*, thus leaving only ships of the new programme for the financial year 1891–'92.

NEW PROGRAMME.

Of the thirty-eight vessels of the new programme under the Naval Defense Act that are to be built in the dock-yards, twenty-one have already been commenced, seven more will be commenced in 1890–'91, and only ten will be left to be commenced after March, 1891. The ten thus left till after next year are five second-class cruisers (*Apollo* class) and five torpedo gun-boats.

Of the thirty-two vessels that have to be built by contract under the Naval Defense Act, twenty-six were ordered before the close of 1889. The remaining six vessels are torpedo gun-boats, which admit of being rapidly constructed, and which have been held over for the present.

These twenty-six vessels include four battle-ships of the first class, five protected cruisers of the first class, and seventeen protected cruisers of the second class,—total, twenty-six.

The work has been widely distributed. Eight of the vessels are building on the Tyne, eight on the Clyde, four on the Thames, three at Barrow, two at Hull, and one on the Mersey.

The whole of the thirty-two vessels to be built by contract have thus been placed except six torpedo gun-boats, which have been kept back purposely pending the conclusion of the steam trials now going on.

The estimated total expenditure on the Navy in 1890–'91 is $93,283,120.

VESSELS PROPOSED OR LAID DOWN.

FIRST-CLASS BATTLE-SHIPS (14,150 TONS).

The keel of the *Hood* was laid at Chatham, in August, 1889; the *Royal Sovereign*, at Portsmouth September 30, and the *Repulse*, at Pembroke, January 1, 1890.

The *Ramillies* was given by contract to J. & G. Thompson of Glasgow; the *Resolution* and *Revenge* to Palmer & Co., of Jarrow, and the *Royal Oak* to Laird Bros., of Birkenhead; all four vessels to be delivered May, 1893. The keel of the *Royal Oak* was laid in May, 1890.

The contractors furnish the engines for their vessels, but Messrs. Humphreys & Tennant furnish those for the four building at Government dock-yards. (See pages 87, 97, and 334, No. VIII.)

SECOND-CLASS BATTLE-SHIPS.

Centurion and *Barfleur* (page 334, No. VIII) are both to be built by the Government; one at Portsmouth and the other at Chatham.

Some changes have been made in the original plans of these vessels, and it is reported that they are to displace at least 11,000 tons

Their proposed armament is four 10-inch, 30-ton, B. L.; ten 4.7-inch R. F. G.; seventeen R. F. G. of smaller calibre and six torpedo-tubes.

Orders were received at Chatham early in April to commence work on the *Barfleur*.

FIRST-CLASS PROTECTED CRUISERS. (Page 334, No. VIII.)

The keel of the *Hawke* was laid at Chatham, June 17, 1889; the *Edgar* at Davenport, June, 1889, and the *Centaur* at Portsmouth, January 20, 1890. The *Crescent* will be laid down at Portsmouth as soon as a slip is vacant.

The *Grafton* and *Theseus* have been awarded to the Thames Iron Company, Blackwall, to be finished in April and September, 1892; the *Endymion* and *St. George* to Earle of Hull, to be finished at the same time, and the *Gibraltar* to Napier of Glasgow, to be finished in May, 1892.

The engines of these vessels have been given by contract to the following firms: The Fairfield Ship-building Company, 2 sets; Earle of Hull, 3 sets; Humphreys, Tennant & Co., 1 set, and Maudslay, Sons & Field, 1 set. They are to be of the vertical-inverted triple-expansion type, with cylinders 45, 59, and 88 inches diameter, and 51-inch stroke.

Boilers: Six, doubled-ended, cylindrical, with 48 furnaces.

The contracts for the hulls range from $912,285 to $1,082,277, and for the machinery from $470,037 to $483,399.

A change has been made in the designs of the vessels of this type that are building at Government yards. They are to have top-gallant forecastles, instead of flush upper decks. This alteration entails a change in the armament. The forward 9.2-inch 22-ton gun will be replaced by two 6-inch R. F. 5½-ton guns, so that in the guns alone, without counting their mountings, there will be a saving of weight of 11 tons to go toward the extra weight of the forecastle.

Their I. H. P. is to be 12,000 under forced draft, 10,000 under natural draft, and 5,500 on a continuous natural draft run of ninety-six hours. It is calculated that these powers will drive the ships at the rates of 19.5, 18.5, and 16 knots an hour, respectively, for the sheathed ships, and a quarter of a knot more for the unsheathed ships.

SECOND-CLASS PROTECTED CRUISERS.

Of the twenty-nine proposed (page 334, No. VIII), four have already been laid down in Government dock-yards; the *Andromache*, *Apollo*, and *Æolus*, at Devonport, and the *Brilliant* at Sheerness.

The *Astrea* and *Bonaventure* are to be laid down at Devonport as soon as slips are vacated.

Seventeen were given out by contract in July, 1889, all to be completed by July, 1891. They are distributed as follows: the *Indefatigable*, *Intrepid*, and *Iphigenia* to the London and Glasgow Engineering and Shipbuilding Company of Glasgow; the *Latona*, *Melampus*, and *Naiad*, to the Naval Construction and Armaments Company of Barrow-in-Furness; the *Pique*, *Rainbow*, and *Retribution*, to Palmer's Shipbuilding

Company of Jarrow-on-Tyne; the *Sappho* and *Scylla* to Samuda Brothers of Poplar; the *Sirius* and *Spartan* to Sir W. G. Armstrong, Mitchell & Co. of Newcastle-on-Tyne; the *Sybille* to R. Stephenson & Co., and the *Terpsichore*, *Thetis*, and *Tribune* to J. & G. Thomson of Glasgow.

The contract prices range, for the hull, from $416,372 to $472,875; for the machinery, from $304,036 to $331,022.

These vessels are to have complete R. F. G. batteries, and many of them will be sheathed and have flush spar-decks. Their protective decks will be from 1 to 2 inches thick, and 5-inch inclined armor will surround the upper part of their cylinders.

TORPEDO VESSELS (SHARPSHOOTER TYPE.)

ANTELOPE.

Keel laid October 21, 1889, at Devonport; will probably be ready for launching early this summer.

CIRCE—HEBE.

Orders were received in January, 1890, to immediately begin work on these vessels in the dock from which the *Gossamer* and *Gleaner* had been recently launched.

A total sum of $177,975 is to be expended for dock-yard and contract work on the *Circe* and *Hebe* during the present financial year.

(Page 335, No. VIII.)

LEDA—ALARM.

Orders were received at Sheerness in April and May, 1890, to prepare the plans of these vessels, and the Admiralty have decided to build eleven others of a similar type, which are to be named *Jaseur*, *Jason*, *Niger*, *Onyx*, *Renard*, *Speedy*, *Dryad*, *Hazard*, *Halcyon*, *Harrier*, and *Hussar*.

The designs of these vessels may be modified as a result of experiments with the *Sharpshooter* type.

Work was commenced on the *Leda* in May.

VESSELS LAUNCHED.

BLAKE.

First-class protected cruiser, described on page 301, No. VII, was launched in November, 1889.

It is reported that this vessel is to carry R. F. guns instead of the 6-inch B. L. at first proposed.

BLANCHE—BLONDE—BARHAM.

Third-class protected cruisers, described on page 302, No. VII, were launched in September and October, 1889.

LATONA.

The first cruiser of the "improved *Medea* type" to take the water, was launched from the yard of the Naval Construction and Armaments Company at Barrow on May 22. She is expected to be ready for her battery in two months.

PANDORA—PELORUS—PERSIAN—PHŒNIX—PSYCHE.

Protected cruisers for special service in Australasian squadron (pages 304, No. VII, and 335, No. VIII) have been launched since June, 1889; the *Pandora*, *Phœnix*, *Pelorus*, and *Psyche*, in August, October, November, and December, 1889, and the *Persian* in February, 1890.

The names of these vessels have been changed as follows: *Pandora* to *Katoomba*, *Pelorus* to *Mildura*, *Persian* to *Wallaroo*, *Phœnix* to *Tanranga*, and *Psyche* to *Ringarooma*.

GOSSAMER—GLEANER.

Torpedo vessels of the *Sharpshooter* type, described on page 303, No. VII, and on page 336, No. VIII, were launched at Sheerness on January 9, 1890.

It is estimated that they will cost $288,987 apiece.

WHITING—WIZARD.

Torpedo vessels of the *Sharpshooter* type; launched in July and August, respectively.

Their names have been changed to *Boomerang* and *Karakatta*.

REDPOLE—SPARROW—THRUSH—WIDGEON.

Partially protected gun-boats (page 303, No. VII); launched in June, September, October, and August, 1889.

MARTIN (FORMERLY MAYFLOWER).

Training brig mentioned on page 335, No. VIII; launched in January, 1890.

MOSQUITO—HERALD.

The *Mosquito*, first of two stern-wheel gun-boats, destined for service in the Zambesi River, was completed at Messrs. Yarrow and Company's yard, Millwall, on May 3, twenty-five working days after the receipt of the order to build her.

These steamers are 77 feet long, by 18 feet beam. They have a draught of 18 inches with steam up, and a speed of 10 statute miles an hour, which is as high as is practicable when navigating a very shallow river. The boiler, which is placed forward, is adapted for burning wood, the only fuel obtainable up the rivers in East Africa. The weight of this boiler at the bow is balanced by the wheel and engines aft, which are of the simplest possible construction. The engines moving slowly are not liable to accidents or excessive wear and tear such as are found with engines running at a high speed.

On May 5 the leading authorities of the Admiralty inspected the *Mosquito* and had a trial on board of her which gave most satisfactory results.

The armament will consist of 3-pdr-Hotchkiss and 5-barrel Nordenfeldt guns.

The contractors are to ship the boats in pieces, and they undertake to put them together at the mouth of the river, and have them ready for steaming within twenty-four hours after arrival. (The *Mosquito* was actually put together in six hours and forty-five minutes.) The second boat is also completed, and has been named the *Herald*.

STEAM TRIALS.

The trials of English war-ships during the last year have demonstrated that it is difficult to make small vessels strong enough to withstand the vibration of powerful modern engines, and that boiler-tubes are very liable to give out under forced draft.

The following outline of a competitive sea trial, in which five battle-ships, one cruiser, and one torpedo vessel took part, is interesting as showing the effect of weight and size on sea-going speed:

Results of a four-hour run at full speed.

	Tons displacement.	Knots.
Benbow (B. S.)	10, 600	61½
Scout (T. V.)	1, 600	58
Phaeton (P. C)	4, 300	57
Colossus (B. S.)	9, 420	56½
Edinburgh (B. S.)	9, 420	51
Téméraire (B. S.)	8, 540	50½
Dreadnaught (B. S.)	10, 820	48

The *Dreadnaught* was properly the slowest ship and the *Scout* properly the fastest if it were a mere question of horse-power to tonnage, for the *Dreadnaught* has only 76 I. H. P. per 100 tons of displacement, and the *Scout* has 202. Yet the gain of speed, taking the *Dreadnaught's* run as 100, is but 21 per cent., while the gain in power is 166 per cent. on tonnage to be driven.

The *Benbow*, which proved herself the fastest ship on the run, has 109 I. H. P. per 100 tons. She beat the *Scout* 6 per cent., notwithstanding the latter had nearly twice as much power in proportion.

TRAFALGAR.

A battle-ship of 12,500 tons displacement, fully described in Nos. VII and VIII, has given great satisfaction on her trials.

In July, 1889, she made a mean speed of 17.25 knots in four runs over the measured mile with forced draft, and 16.22 knots with natural draft. The I. H. P. was 12,800 with forced draft and 8,590 with natural draft, this last number being more than a thousand I. H. P. in excess of the contract.

In April, 1890, on her commission trials, she made a mean speed of 15 knots during a three hours' run with natural draft and 7,488 I. H. P.

MINOTAUR—TRIUMPH.

The *Minotaur*, a broadside armor-clad of 10,690 tons displacement, completed in 1867, having been refitted and repaired at Portsmouth, at an estimated cost of $257,000, made a successful trial of her machinery in April, 1890.

She developed 4,800 I. H. P., which gave a speed of 14 knots.

The appearance of R. F. guns has rendered vessels of the above type valuable as armored cruisers. Their batteries are completely protected by from 3 to 5½ inch armor, and their great length, 400 feet between perpendiculars, will enable them to carry good speed in a sea-way.

The *Triumph* also has her battery completely protected, and her armor is from 6 to 8 inches thick, but she displaces only 7,000 tons, and on her trial, after refit, made but 12.5 knots with 3,659 I. H. P.

BARROSA—BARRACOUTA—BLANCHE—BLONDE—BARHAM.

Third-class protected cruisers of 1,580 tons displacement, described on page 302, No. VII.

The *Barrosa* had a satisfactory natural-draft trial during the latter part of October, 1889, making a speed of 14.925 knots with 2,125 I. H. P.; but a forced draft trial, which took place on November 6, resulted in failure. She only obtained 2,561 I. H. P. instead of the specified 3,000; and the speed, 14.7 knots, was less than that obtained under ordinary draft.

After strengthening the cylinder supports to stop the excessive vibration and readjusting the low-pressure slide-valves, a second trial was given on November 19, which was also unsuccessful. All went well for one hour and the required I. H. P. was obtained with a margin, but after this the tubes leaked and the starboard air-pump broke down. The trial was then abandoned.

On November 23 another attempt was made, which at last gave satisfactory results. The conditions of this trial were four hours' continuous full-power steaming under forced-draft. Since the last abortive run under like conditions the grate-surface in each of her eight furnaces had been lengthened 16 inches and the exhaust-ports of her low-pressure cylinders enlarged.

In all respects this trial was highly satisfactory; in fact, both in power and speed the performances were in excess of the estimates. The 3,110 I. H. P. obtained gave a speed of 16.868 knots over the measured mile.

It is said that this vessel is to be strengthened and stiffened with additional angle-plates and deck beams before having further trials.

The *Barracouta* has had three unsuccessful trials, and the last one ended in a serious disaster.

The first occasion was on January 30, 1890, when the steering-gear gave a considerable amount of trouble, and she returned to dock for repairs.

On the following Thursday the ship proceeded to sea again for another trial, but after an absence of an hour she returned to harbor, the trial having to be postponed through a leakage in the joints of her cylinder cover.

At 7 a. m. February 7 the *Barracouta* left Sheerness harbor to resume her trial, which was to be of eight hours' duration under natural draft. The engines were, as usual on such occasions, in charge of representatives of the contractors. All went well for a time, but suddenly great volumes of flame burst from the furnaces of the port boiler and seriously injured ten men, one of whom has since died.

The evidence given before a coroner's jury shows that the accident was not due to any fault in the design or construction of the boilers, and the verdict given was as follows:

> That the deceased came to his death by shock from burns received in the stokehold of H. M. S. *Barracouta*, caused by flames suddenly issuing from the ashpits of the port boiler, owing to the combustion chamber tubes and tube-plates becoming overheated from shortness of water or ebullition in the boiler, thereby producing local expansion and contraction and allowing the steam to escape into the combustion chamber and cut off the exit of the flames through the tubes.

Some authorities do not agree with the above conclusion, but ascribe the accident to back-draft due to the facts that the smoke-pipes were too short and the fires so heavily covered that the supply of air was cut off.

The *Blanche* had a successful natural-draft trial on March 18, but a forced-draft trial that took place on March 29 was not so satisfactory. The engines worked very smoothly but the required I. H. P. was not reached until the sixth half hour, when 3,050 was developed and a speed of 16 knots attained. A few minutes afterwards the boiler-tubes began to leak and the trial was discontinued.

On April 31 she went out into the channel from Devonport for a four hours' forced-draft trial of her engines and boilers. After two hours and a half the steam-taps in both boilers gave out, and the trial had to be discontinued.

The *Blonde* was taken outside Plymouth breakwater on May 1 for eight hours' trial under natural draft. After three hours' steaming the trial was discontinued, as owing to the incomplete state of the casings the necessary air pressure could not be maintained in the fireroom.

The *Barham* went out in May for a contractor's preliminary trial of her engines. The starboard engines were worked steadily for three and a half hours up to 180 revolutions per minute, developing 1,854 I. H. P.; and the port engines to 150 revolutions, with 1,136 I. H. P., but owing to excessive movement in the thrust-block bearings it was not considered advisable to drive the engines any faster. They thus developed 2,990 I. H. P. instead of 3,330. The engines and boiler worked well and the Government officials were highly satisfied. She was designed to go 19.5 knots an hour on the measured mile under forced draft, 17.5 under natural draft, and 14.75 continuous sea-going speed for 96 hours, provided her coal supply, 140 tons, would last for four days steaming at this rate. On the above trial the speed was about 16 knots.

MEDEA—MEDUSA—MAGICIENNE—MELPOMENE.

Protected cruisers of about 3,000 tons (page 337, No. VIII). The vessels of this class have been severely criticised. They are said to be so low in the waist that when steaming against a head sea it is impossible to work their midship guns. It is also asserted that they are too lightly built for their machinery, and that they have never made anything like their trial speed at sea.

The *Medea* made over 19 knots on her trial, but in the smoothest water, under most favorable circumstances, could not quite touch 16 knots when she was sent out to Gibraltar last summer.

Alterations are to be made in her engine and boiler rooms, new steel tubes are to be fitted, and certain modifications made in the combustion chambers of her boilers with a view to increasing her speed. The hull is to be stiffened aft by additional angles and supports, the ventilating and other hatches are to be fitted with combings to prevent the lower decks being flooded with water when steaming against a head sea, and alterations are to be made in the means of getting coal into the bunkers and thence to the fires.

The *Magicienne*, during the past year, has had several unsatisfactory trials. She only passed her contractor's trial at the third attempt; and although she then nearly reached her nominal highest speed of 19.75 knots, she has never made it since with her regular crew and average coal.

She is the first of the M class to be detailed for service, and her three hours' commissioned trial took place on May 8, at Portsmouth.

The trial proved more than usually successful, the mean power developed being over the natural draft contract power, though neither picked coal nor special firemen were made use of. The collective I. H. P. realized was 5,526 and the mean speed 16½ knots, or nearly the same as was obtained under exceptional conditions and with the maximum air-préssure permitted.

The temperature in the engine and boiler rooms was all that could be desired, the surfaces of the steam-pipes, boilers, and cylinders having been coated with fossil powder and additional ventilating trunks and cowls fitted. The highest temperature recorded was 97° F.

The *Melpomene*, during last summer's manœuvres, was unable to keep up for 200 miles a higher rate of speed than 15 knots at the outside, although her natural-draft trial developed a mean of 6,216 I. H. P. or 716 more than the contractors had agreed to furnish, and the average speed for 12 hours was 17.645 knots by patent log, which means a run of 212 miles. The reason given for this falling off in speed is that the forced-draft trials ruined her boilers.

Medusa.—Considerable trouble having been experienced with the M class of cruisers in getting the required speed, though the I. H. P. had been considerably in excess of that required, it was decided to make a number of progressive trials on the *Medusa* with different propellers, and these were carried out by Mr. R. R. Humphrys, of the firm of Humphrys, Tennent & Co., the builders of the engines.

Three propellers were tried and the most successful one, 13 feet, 6 inches diameter and 17 feet pitch, gave a speed of 19.92 knots with 10,011 I. H. P.

This result is not very satisfactory, for when the vessels were designed 20 knots was expected with an expenditure of only 9,000 H. P.

BEAGLE—BASILISK.

Gun-vessels of 1,170 tons displacement; had final trials in August and October, 1889.

The *Beagle* made 13 knots on 1,551 I. H. P. and 13.5 on 2,106.

The *Basilisk* made 13.1 knots and 1,486 I. H. P. with natural-draft, and 13.9 knots and 2,107 I. H. P. with forced-draft. (Page 336, No. VIII.)

MAGPIE—SPARROW—LAPWING—GOLDFINCH—REDBREAST—REDPOLE—RINGDOVE—THRUSH—WIDGEON.

First-class composite gun-vessels of 805 tons, mentioned on page 336, No. VIII.

The *Magpie* had successful natural-draft trials on October 15, 1889. I. H. P. 749; revolutions, 156.1; speed, 12.9 knots.

On the 20th she commenced a full-power trial, but at the end of ten hours her boiler-tubes were leaking so badly that she could not keep at sea.

On March 18, 1890, she had her "first commissioned four hours' full speed steam-trial," which was satisfactory. Average speed, 11.8 knots; average I. H. P., 831.19; engines worked smoothly and well, and showed no defects, but the temperature ranged from 130° to 170°, and "there is no doubt whatever that the ventilation in this class of vessel requires alteration and improvement."

The *Sparrow* has proved very successful under both forced and natural draft, as will be seen by the following results: January, 1890, an eight-hours' run in the North Sea under natural draft; average I. H. P., 803.9; revolutions, 157.7. Forced-draft, four hours continuously; average I. H. P., 1,240; revolutions, 175; speed over measured mile, 13.5 knots.

The *Lapwing* had a number of unsatisfactory trials during the summer and autumn of 1889. On every occasion the boiler-tubes leaked before the trial was concluded. On October 13, with 1,210 I. H. P. and 187.2 revolutions, she made 13.41 knots.

The *Goldfinch* had her official natural-draft trial in the North Sea in November. It was of a very successful character throughout, there being an absence of priming or hot bearings. The I. H. P. developed was 796, or 76 in excess of the contract, with a speed of 12.15 knots.

The forced-draft trial took place on November 30, when her speed, 15.5 knots over the measured mile, gave great satisfaction, although the machinery did not quite attain the required I. H. P.—1,196, instead of 1,200 required. This vessel cost $237,650.

Redbreast.—After six trials, which failed to give good results, generally owing to leaky boiler tubes, this gun-vessel had satisfactory forced-draft trials on October 29, 1889, and March 13, 1890. The best speed obtained was 13.9 knots, with 1,222 I. H. P.

Redpole.—On July 30 a natural-draft trial gave the following good results: I. H. P. 936 (216 more than required); speed, 13.2 knots.

The forced-draft trial took place on August 1, and with 1,240 H. P. and 185.5 revolutions gave 14.4 knots mean speed during four hours.

Ringdove.—Early in August, 1889, had a twelve hours' trial of her machinery. The engines worked satisfactorily, and developed 60 H. P. above the specified amount. The mean results were: I. H. P., 784; revolutions, 161.2; speed, 11.8 knots.

On August 8th, a forced-draft trial was commenced, but discontinued on account of leaky tubes. In October of the same year, she went outside Plymouth breakwater and ran under forced-draft for four hours, giving what were considered satisfactory results, but the power obtained was low on account of continued priming. I. H. P., 1,127; speed, 13 knots.

Thrush.—In January, 1890, during an eight hours' natural-draft trial developed 804.5 I. H. P., 84.5 more than required.

The engines worked smoothly without hot bearings, while the boilers gave a plentiful supply of steam with a total absence of priming.

On January 14 she went out for a forced-draft trial, which bade fair to be successful, but at the end of two hours one of the small fan engines for ventilating gave out and trial was postponed until later in the month, when good results were obtained. The engines developed 15 H. P. in excess of the contract, and the boilers gave plenty of steam with no priming.

Widgeon.—On December 10, 1889, natural-draft trial for eight hours gave 851 I. H. P. (134 above contract), and 12.5 knots speed.

On December 12 a four hours' forced-draft trial gave 1,259 I. H. P. (59 above contract), and 13.5 knots speed.

SHARPSHOOTER—SEAGULL—SPEEDWELL—SPANKER—SKIPJACK—SHELLDRAKE—GRASSHOPPER—SALAMANDER—WHITING—WIZARD.

These torpedo vessels, described on page 303, No. VII, like the *Magpie* class of gun-boats, have shown signs of weakness during their forced-draft trials.

The following accidents are noted as having occurred on board the *Sharpshooter:*

June 1, 1889, fracture of low-pressure valve gear.

June 3, steam-pipe broke, owing to excessive vibration.

June 24, engine worked smoothly until the fourth hour, when one lever of the reversing gear carried away. During the ninth hour one of the eccentric rods broke.

In July and August, boiler tubes leaked badly in working up steam-pressure to 150 pounds.

Alterations are being carried out in the *Sharpshooter* and *Spanker*, which it is hoped will enable them to go through their steam-trials satisfactorily. The tube plates of their boilers are being covered with a protective substance, and a method of circulating the water in the boilers is being introduced (April 3, 1890.) The hulls have been strengthened by fitting additional supports in the bunkers on both sides of the engine and boiler rooms.

The *Spanker* had trials in November, but was not able to run more than three hours without leaky tubes.

The *Seagull* on November 28, 1889, ran from Sheerness to Portsmouth in nine hours, making an average speed of 18 knots. The weather was somewhat rough, with a strong head-wind all the way, and the seas constantly broke over her, but the ship behaved very well and the machinery worked without a hitch.

Her machinery is to undergo a series of progressive steam-trials to determine the utmost power that can be developed without undue straining of engines and boilers.

The *Speedwell* had a very successful natural-draft trial on October 29, 1889, 17.35 knots being obtained with 2,594 I. H. P. On February 4, 1890, she went out from Portsmouth harbor for the first of a progressive series of steam-trials under forced-draft.

This vessel differs from her sister-ships in being structurally stronger, and slight differences have been made in the engines and boilers.

This trial, in consequence of the repeated failures of the type, was deemed sufficiently important to demand the presence of Mr. W. H. White, director of naval construction, and Mr. Durston, the engineer-in-chief of the Navy. There was much less vibration than in the other vessels of the class, but as regards the engine trials there was no break in the monotony of failure.

The contract power of the engines with closed firerooms is 4,500, I. H. P. but it was not intended to press them beyond 3,500, that being about the power at which weaknesses displayed themselves at previous runs of her sister-ships.

When the trial had proceeded to within five minutes of the specified 3-hours steaming, the tubes of two of the boilers leaked to such an extent that nothing further could be attempted.

Further trials that took place in April gave more satisfactory results, and it is understood that she has been accepted by the Admiralty. The engines gave 3,584 I. H. P., and a speed of 19.4 knots was obtained. The machinery worked satisfactorily and the boilers gave no trouble. Her smoke pipes are to be lengthened about 6 feet.

The *Skipjack*, *Shelldrake*, *Grasshopper*, and *Salamander* have all had satisfactory natural-draft trials, showing an average I. H. P. of 2,600, and 18 knots speed. Their hulls have been strengthened and important alterations have been made in their engine and boiler rooms.

The *Skipjack* was preparing (May 1, 1890) for an exhaustive series of experimental trials at Portsmouth. She is to have her smoke pipes lengthened.

The *Whiting* and *Wizard*, which are completing at Elswick, have both been out for their preliminary trials, (May, 1890), which were fairly satisfactory. A speed of 17.5 knots was obtained, but some slight defects showing themselves, it was not thought advisable to work the engines up to 18 knots, which is the contract speed under natural draft, so both vessels will have to make another run.

It is reported that the Admiralty have decided to reduce the required I. H. P. and speed of this class from 4,500 and 21 knots to 3,500 and 19.5 knots.

IRIS.

A dispatch cruiser of 3,730 tons, built in 1879, having been generally refitted, and supplied with a new steel crank-shaft, had successful trials in April, 1890. With 6,658 I. H. P. and 89.5 revolutions she obtained a mean speed of 17 knots.

The *Mercury*, a sister-ship of the above, made 16.25 knots with a mean I. H. P. of 6,000 on her commission trial. At the contractor's forced-draft trial the engines developed 7,290 I. H. P. and an average speed of 18 knots was obtained.

MELITA.

A fourth-class cruiser (page 197, No. VI, and page 306, No. VII), went out on November 13 for trial, and obtained a mean speed of 10.75 knots during a three hours' run.

WHITE'S "TURN-ABOUT" VESSEL.

An experimental trial has just been made in Stokes Bay, Portsmouth, of a new torpedo vessel built by Mr. J. S. White, of East Cowes, on his well known "turn about" system, and engined by Messrs. Bellis & Co., of Birmingham. The vessel is a further development of the *Swift* type of torpedo catcher, supplied to the Admiralty by the same builder two years ago and known as No. 81. It is however longer by 50 feet, with proportionately greater beam and superior accommodation, and whereas the *Swift* was only capable of stowing 45 tons of coal in her bunkers, the present boat can stow 100 tons. Substantially it may be said to resemble the *Rattlesnake*, but draws less water.

The trial consisted of an hour's run with natural draft, when a speed of 18.64 knots was obtained. This was followed by a full power trial of another hour's duration, the result being a mean speed of 21.46 knots.

Circles were turned to port and starboard in one and three fourths minutes, the diameter of the circles being about two lengths of the vessel.

The weights carried were 50 tons of coal and 40 tons of ballast to represent armament, stores, etc., making a total of 90 tons. There was remarkably little vibration, and no perceptible inclination when the rudders were put hard over.

The dimensions of this vessel are: Length, 209 feet; beam, 23 feet; extreme draught of water when fully loaded and equipped, 8 feet 4 inches.

The maximum coal capacity of the bunkers is 100 tons, which is more than the usual capacity in craft of this size and indicated horse-power. This would enable her to accompany iron-clads on long voyages and to act as a scout, for which duty her exceptional speed would prove a valuable factor, while her comparatively shallow draught would allow of her following torpedo-boats into shoal water.

TORPEDO-BOATS.

All the torpedo-boats which were in progress at the beginning of the financial year have been delivered by the builders, and it is not proposed to order any new boats in 1890–'91. (See No. VII, page 399, and No. VIII, page 439.)

The ten second-class Yarrow boats were delivered at Chatham in April, and have had their machinery tested.

STEAM TRIALS.

The six first-class torpedo-boats recently built for the Admiralty by Messrs. Yarrow & Co., represent the latest type of English sea-going boats, and they have had very successful trials.

The first five of them attained on the official trial with a load of 20 tons on board, a mean speed of 22.6 knots per hour during a continuous run of three hours.

No. 87, the last one, attained a mean speed of 23 knots under the same conditions. The speeds on the successive knots were as follows:

		Means.	Second means.
First knot	20,000	......	......
Second knot	26,086	23,043	......
Third knot	20,111	23,098	23,070
Fourth knot	25,899	23,005	23,051
Fifth knot	20,111	23,005	23,005
Sixth knot	25,899	23,005	23,005
			4) 92,131
Second mean			23,032

The runs were made at stated intervals during the three hours' trial, without any alteration whatever in the working of the machines. On the day of trial there was a strong ebb-tide running, and the wind was blowing in the same direction. This accounts for the difference in speeds with and against the tide.

These boats are 130 feet long at the water-line, by 13 feet 6 inches beam, and their displacement, with bunkers full of coal, and armed and provisioned complete, is about 95 tons. They are propelled by triple-expansion engines capable of giving 1,130 I. H. P. on a continuous run: and they have steel boilers of the locomotive type.

Sufficient coal is carried to take them 2,000 knots at 10-knot speed, which renders them serviceable as sea-going boats for scouting duty. Their manœuvring powers are very remarkable, as they will turn a circle at full speed of a diameter of twice their length; the time of making the complete circle varying from one minute to one and a quarter.

Their armament consists of one tube, built in the bow for direct head fire, and two, mounted on a turn-table aft, are arranged to discharge on either beam at any desired angle.

There are four R. F. G.; one on top of the conning-tower, and three so mounted as to be available on either broadside.

Four torpedo boats, Nos. 30, 31, 32, and 69 (90 tons displacement), left Plymouth, England, for Bermuda on July 28, 1889. They were convoyed across the Atlantic by the transport *Tyne*, which supplied them with coal and water and rendered assistance when necessary. A number of accidents occurred, but all arrived safely at their destination on August 21.

Four more first-class boats are to be sent out in the spring of 1890.

FRANCE.

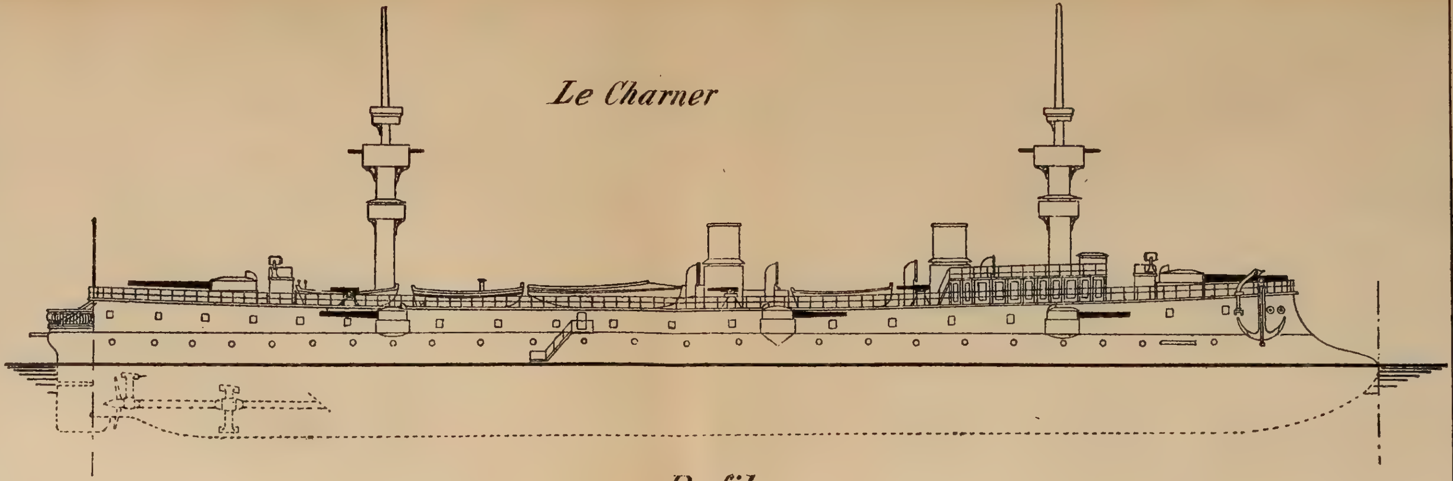
An extraordinary credit of 58,000,000 francs ($11,600,000) for the construction of new vessels was asked by Admiral Krantz, Minister of Marine, in July, 1889, and immediately granted by the Chamber of Deputies. On November 21 of the same year the appropriation passed the Senate by a great majority, and the work was at once undertaken.

In addition to the above, the Ministry will ask for 59,910,200 francs ($11,982,040) for use in 1891, to be expended during that year in new construction.

The following vessels will be in course of construction at the French Government and private yards during the year 1890–'91:

10 battle-ships.
1 armored cruiser of the first-class.
4 armored cruisers of the second-class.
2 first-class cruisers.
4 second-class cruisers.
7 torpedo vessels.
2 armored gun-boats.
1 transport dispatch boat.
12 sea-going torpedo-boats.
35 first class torpedo-boats.

Le Charner



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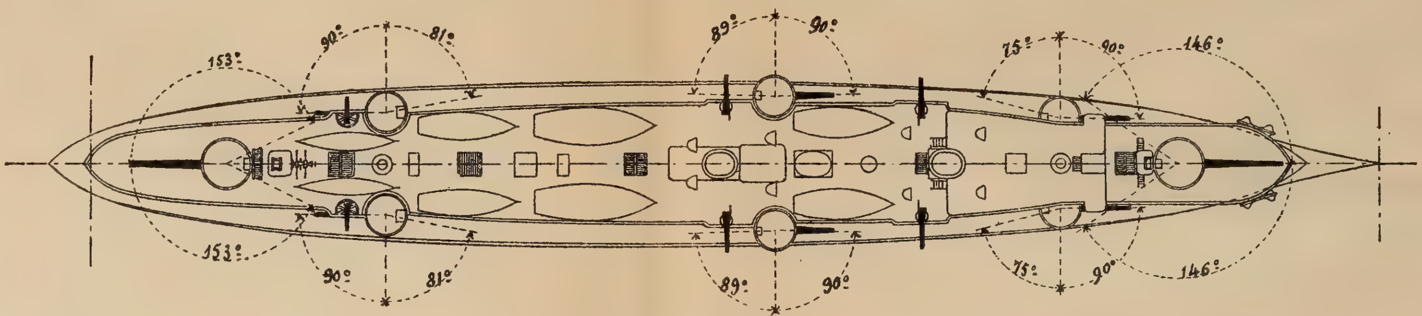
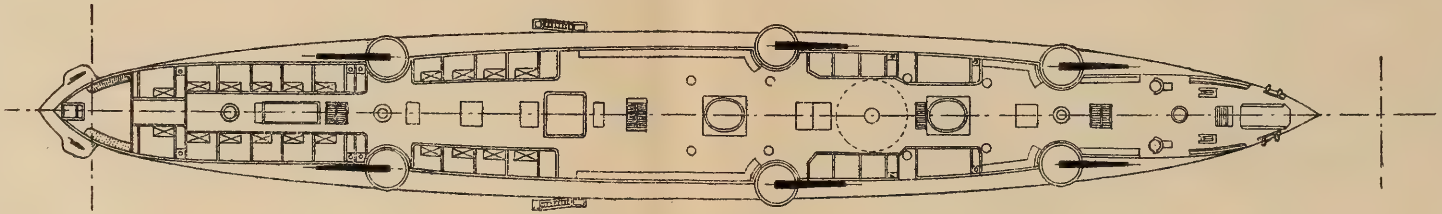
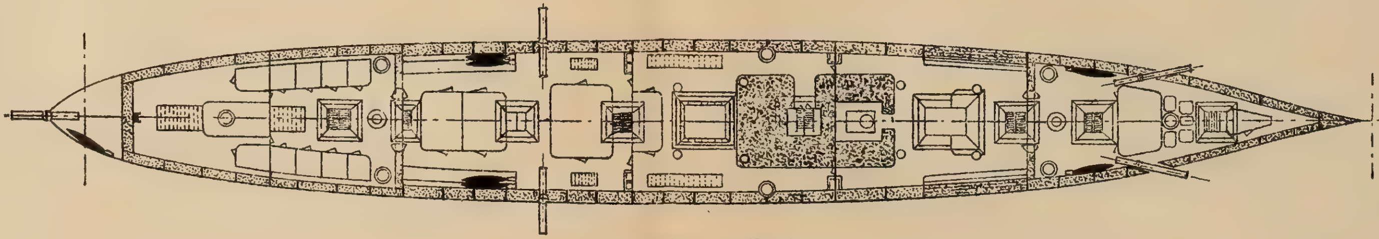


Spar Deck



Gun Deck



Orlop Deck

VESSELS PROPOSED OR LAID DOWN.

BATTLE-SHIPS.

Three of this class of more than 10,000 tons displacement are provided for in the budget of 1891. The plans are not yet decided upon; and possibly a displacement of 15,000 tons will be adopted, as a strong party is in favor of it. One of these ships, to be called the *Carnot*, is to be laid down on the slip lately occupied by the *Magenta* at Toulon. The sum of $320,000 is to be expended on these vessels during 1890.

COAST-DEFENSE VESSELS.

The keel of the *Tréhouart* (page 341, No. VIII) was laid at L'Orient in September, 1889; and three more of this class, the *Jemmapes*, *Valmy*, and *Bouvines*, are provided for in the credit of 58,000,000 francs granted last year. These vessels are to be heavily armed and well protected, carrying two 13.4-inch guns, and having armor about 18 inches thick. Displacement, 6,589 tons; extreme draught 23.2 feet.

The *Jemmapes* and *Valmy* are to be built by the Société des Chantiers de la Loire at St. Nazaire, and the *Bouvines* by the Société des Forges et Chantiers de la Méditerranée at La Seyne. The first two should be completed in forty months, and the third some months later.

PROTECTED CRUISERS.

CHARNER, BRUIX, LATOUCHE-TRÉVILLE, CHANZY.

These vessels (page 341, No. VIII) are first-class protected cruisers of a modified *Dupuy-de-Lôme* type, having side armor 3.6 inches thick, extending from the rail to 3 feet 11 inches below the water-line. A protective deck 1.5 to 2 inches thick curves down and meets the ship's side at the lower edge of the armor, and a coffer-dam filled with cellulose extends completely around the ship at the water-line.

The battery consists of two 19-centimetre (7.48-inch), six 14-centimetre (5.51-inch) B. L., and fourteen R. F. G.

Two horizontal triple-expansion engines are expected to give 8,300 I. H. P. and 19 knots with forced draft, and 7,400 I. H. P., and 17 knots with natural draft.

Dimensions: Length, 347 feet 9 inches; beam, 45 feet 10 inches; draught, 19 feet 7 inches; displacement 4,745 tons.

The Government is building the *Charner* and *Bruix* at Rochefort and Toulon, respectively, and their keels were laid in September, 1889. The *Latouche-Tréville* and *Chanzy* are to be built by contract, the former by the Forges et Chantiers de la Méditerranée, at La Seyne, and the latter by the Société des Chantiers de la Gironde, at Bordeaux. The two Government built ships are expected to cost $1,798,000 apiece, while those built by contract are estimated at $1,839,000.

Three cruisers, modified *Davout* type, are to be laid down at Cherbourg, Brest, and Toulon.

TORPEDO VESSELS.

The keel of the *Wattignies*, mentioned in No. VIII, page 341, was laid at Rochefort, in September, 1889, and she will probably be completed in 1891.

The *Fleurus*, another vessel of this type, is to be laid down at Cherbourg this year.

The *Léger* and *Lévrier*, 450 tons (page 341, No. VIII), are to be completed this year, and three others of this type are to be commenced.

The new vessels are to be named *Catinat*, *Iberville*, and *Lavoisier*, and are to cost $260,000 apiece without their armament.

VESSELS LAUNCHED.

MAGENTA.

A battle-ship of about 10,600 tons displacement (page 341, No. VIII) was launched at Toulon, April 19, 1890.

She is the fourth and last of her class to take the water. (The *Hoche* is now having her trials, and the *Marceau* and *Neptune* were launched in May, 1887.) They are all four built on the plans of M. Huin, naval constructor, but modifications introduced during the course of construction have led to some differences, the most important being those that concern the armament.

The *Hoche* has two 27-centimetre guns on barbette turrets in the center of the ship, and two 34-centimetre guns in closed turrets forward and aft. In the other three ships a uniform calibre of 34 centimetres (13.4 inches) has been adopted for the heavy guns and they are all mounted on circular barbette turrets.

The *Magenta* has four vertical compound engines of 12,000 I. H. P. that are expected to give at least 15 knots (probably 17 with forced draft).

The maximum thickness of her armor is 17.7 inches, and her estimated cost is $3,800,000. She will probably be completed in 1891.

JEAN BART—ALGER.

First class protected cruisers, were launched in October and November, respectively. They are similar to the *Isly*, having a complete turtle-back deck, 3.94 inches thick and cellulose protection. They displace about 4,100 tons, and are expected to make 19 knots. They will probably be ready for trial before the end of 1890. (Page 256, No. VI.)

DAVOUT.

Second-class protected cruiser, was launched in November, 1889, and will probably be completed early in 1890.

This vessel displaces 3,027 tons, has a complete protective deck 2.4 inches thick, with cellulose protection, and carries six 6.3-inch (16-centimetre) guns, as her main battery. Speed expected, 20 knots.

COSMAO—SURCOUF.

Third-class protected cruisers, were launched in August and October, 1889. The former will be ready for trial this summer, and the latter had preliminary trials in May. (See description of the *Forbin*, page 202, No. V.)

STEAM TRIALS.

CECILLE.

A first-class protected cruiser of 5,766 tons, has had a number of unsatisfactory trials, and it has been found necessary to make radical changes in her machinery. The bearings of the connecting rods heated continually, in spite of important modifications that had been made in them, and it was finally decided that the connecting rods themselves should be changed.

This work having been done, the ship went out on May 6 for preliminary trials, and gave great satisfaction. Several runs were made over the measured mile, and the engines with 82 to 95 turns gave successively 16.85 knots during twenty-four minutes, 17 knots during twenty-five minutes, and finally 18 knots during twenty-three minutes. The engines worked smoothly without heating, and the auxiliary machinery performed perfectly.

(For full description of this vessel and her trials, see pages 80 and 202 No. V; 313, No. VII; and 342, No. VIII.)

TAGE.

First-class protected cruiser, of 7045 tons, has made 17.8 knots with natural draft and 19.2 with forced draft. (Page 201, No. V.)

FORBIN—TROUDE—CŒTLOGON—SURCOUF.

Third-class protected cruisers, of about 1,850 tons, have had very satisfactory trials.

The *Forbin* has made 20.64 knots, and the *Troude* 21.13 over the measured mile, without injury to their engines or boilers.

The *Cœtlogon* commenced trials in May, but they were interrupted by an accident to her port propeller.

The *Surcouf*, on a preliminary run, has made 20.5 knots.

Two others of this class, the *Lalande* and *Cosmao*, are having their ventilators changed, and will be ready in two or three months. (See pages 202, No. V; 313, No. VII, and 342, No. VIII.)

VAUTOUR.

Torpedo vessel of 1,280 tons, terminated successful trials at Toulon in January, 1890, having attained a mean speed of 17.05 knots in a three hours' trial.

The hull of this vessel was built by the Government, but her machinery was given by contract to the Société des Forges et Chantiers de la Méditerranée, and the only requirements were that the engines should develop more than 3,200 I. H. P., and that the consumption of coal per I. H. P. should not exceed 1,100 kilogrammes (2.4 lbs.). After many failures, nearly always due to the bad working of the auxiliary machinery, the ship was accepted on January 9, 1890.

The trials with forced draft lasted three hours, the two engines developing about 3,391 I. H. P. The consumption of coal per I. H. P. was 0.961 kilogrammes, about 2 pounds (see pages 117, No. IV, 260, No. VI and 342, No. VIII).

TORPEDO-BOATS.

The extraordinary grant which became a law in November, 1889, provided for ten sea-going torpedo-boats of about 110 tons and thirty first-class boats of about 80 tons.

In accordance with the above programme the Minister of Marine, early in April, 1890, signed the following contracts:

Type *Avant-Garde*, of 120 tons.—Three to M. Normand, at Havre, and two to the "Chantiers de la Loire."

Type *Agile*, of 103 tons.—Two to the Chantiers de la Gironde; three to the Forges et Chantiers de la Méditerranée.

Type *No.* 126, of 79 tons.—Three to the Chantiers de la Gironde; three to the Ateliers, Cail; three to the Chantiers de la Loire; two to the Creusot Works, three to the Forges et Chantiers de la Méditerranée, and six to M. Normand.

The three types chosen have given excellent results on their trials. (See steam trials.)

The contracts for two deep-sea torpedo-boats, type *Coureur*—120 tons—have been given to the Forges et Chantiers de la Méditerranée, at La Seyne, this firm having obtained a right to the Thornycroft patents. They are to be named *Véloce* and *Grondeur*, and are to be delivered in 1891. (See steam trials for performances of the *Coureur*.)

Ten other deep-sea torpedo-boats are provided for in the estimates for 1891. They are to be named *Coudon*, *Cépet*, *Esterel*, *Faron*, *Sicié*, *Lérins*, *Molène*, *Noirmoutiers*, *Ouessant*, and *Porquerolles*, and $525,000 (about half their value) will be spent on them this year.

One hundred and fifty thousand dollars, out of $300,000 allowed for the transformation of the fifty 35-metre boats, is to be expended in 1890. This shows the estimated expense for each boat to be $6,000.

In March last seventeen of these boats were undergoing alterations; eleven by the Société de la Loire, five by the Société des Anciens Établissements, Cail, and one by the Forges et Chantiers de la Méditerranée.

Fourteen first-class boats will be delivered this year, and twenty-two laid down; numbers 145 to 149, and 150 to 168 inclusive.

STEAM TRIALS.

(See pages 443 and 444, No. VIII.)

The Thornycroft torpedo boat *Coureur* has given great satisfaction to the French authorities, she having rendered excellent service while attached to the Mediterranean squadron last summer. The commander of this squadron, Vice-Admiral Du Petit-Thouars, says:

> "The *Coureur* has shown superior qualities. What she has lost in invisibility she has amply gained by her superior speed and sea-going qualities."

She made 23.6 knots on her trial, and it is said now makes 24 knots "ordinarily."

The *Agile* was accepted in November, 1889, after successful trials. She made 20.42 knots over the measured mile.

The *Ouragon* was designed by the Société des Ateliers de la Loire as a sea-going torpedo-boat of very high speed. Her dimensions are: Length, 151 feet; beam, 15 feet 10 inches; draught, 8 feet 5 inches; displacement, 147 tons.

She was intended to make 25 knots, but has never succeeded in making more than 20 on any of her trials. Although the minimum speed allowed by the contract was 22 knots, the Government has accepted her at a greatly reduced price.

Modified contracts were framed for the sister vessels, *Alarm*, *Aventurier*, *Défi*, and *Téméraire*, all of which are completed.

The *Avant-Garde* was launched at Havre on October 11, 1889, and lost off the coast of Spain in February, 1890.

First class torpedo-boat **No. 126**, of 79 tons displacement, made a mean of 21.1 knots during a four hours' trial over the measured mile. This boat has also had a trial to show her coal consumption at the reduced speed of 10 knots an hour. The contract required that she should carry a supply of fuel sufficient to take her 1,800 miles at this rate, and M. Normand, the builder, had allowed 12 tons of coal to accomplish this result. The trial proved that she could do it on 9.9 tons, a saving of more than 2 tons on the estimate, which will enable an addition to be made to the offensive armament of the boat or to her protection.

No. 127 of the same type had successful trials in September, 1889.

Nos. 128 and **129** are completed.

The *Audacieux* (103 tons), has made 20.5 knots at 290 revolutions, and it is expected that she will reach 21 knots.

First class torpedo-boat **No. 82** had a satisfactory trial at Brest on August 23, and has been accepted by the Government. She was built by the "Ateliers de la Loire," and is one of the modified 35-metre type.

No. 99, also of the modified 35-metre type, had trials of her sea-going qualities on January 11, 1890. After the accident to **No. 102** this boat was sent to the works at La Seyne for alterations, where her upper works were built up vertically from the water-line, the deck was extended to the stem, and the hull strengthened by putting in new stanchions, bulkheads, and carlins. The Société des Forges et Chantiers signed the contract for this work on July 1, 1889, and completed it in November of the same year.

The trials for stability were very satisfactory, the boat behaving well in a rough sea—waves 10 feet high. **No. 99** was accompanied by **No. 65**, of the 33-metre Normand type, and the two boats were compared under different conditions of wind and sea. It was found that **No. 99** behaved better than her neighbor with the wind abeam or astern, but with wind ahead she was not as dry, and it was therefore recommended that the forecastle be raised slightly and covered with a "water-tight caisson" (turtle-back?).

Boat **No. 100** was completed and ready for delivery in March, 1890.

SUBMARINE TORPEDO-BOATS.

GYMNOTE.

Since the trials of this boat, which took place last year (page 453, No. VIII), the time has been profitably employed in remedying some defects that were then developed, and in making certain improvements and additions to her apparatus, which have greatly increased her efficiency.

It is now claimed that she is a decided success; and if all accounts of her performances are true, she will prove a useful addition to the French navy and a powerful weapon for the defense of coasts and harbors.

The most important of these modifications was in the insulation of the electric accumulators; and it was only after a long series of experiments that a satisfactory solution was arrived at. Glass and pottery were first tried, but both of these substances proving too fragile, resort was had to gutta-percha, and after much careful research, a preparation of this material was obtained which gave entire satisfaction.

While this work was going on the boat was supplied with some apparatus destined to facilitate her manœuvring. In order to give the navigator a clear view all around the horizon a "périscope" is used. It is thus described:

A bronze tube, fitted to raise or lower, carries a lenticular prism at its upper end, which reflects the entire horizon, and is put together in a water-tight manner between the tube and an outer covering. The rays of light after being reflected in the prism converge at a certain point and are received by a lens, of which the principal focus coincides with the point of convergence. It is thus transformed into a vertical, cylindrical pencil, which, passing to the bottom of the tube, strikes a mirror inclined at an angle of 45°, and is projected horizontally to the eye of the observer.

An electric gyroscope has been installed, which indicates the course and replaces advantageously the compensated compass, which, by its position in a hull of steel, and in the midst of deflective currents, is fatally defective.

An electric ventilator quickly renews the air when the boat arrives at the surface; a servo-motor enables her to be steered from all the points of vision, and a special sounding lead can be used to obtain the depth of water or to act as an anchor.

The trials which took place last December in the harbor of Toulon are thus reported:

The boat was hermetically closed during the entire trial, which lasted four hours. She ran over a measured course, about three-quarters of a mile long, at a depth of about 8 feet, maintaining her position easily with a variation of not more than 8 inches; she remained out of sight ten minutes at a time, and left no trace of her passage on the surface of the water. The gyroscope gave the direction with mathematical precision.

When the trial ended, the air in the interior was as easy to breathe as at first, and enough electricity remained in the accumulators to last several more hours.

Vessels, buoys, chains, etc., were easily avoided while running through the inner harbor.

Other trials, which took place on February 22 and April 23, 1890, have also been reported as very successful. The boat is now hauled up on the ways, and certain "supplementary work" is to be done on her which it is expected will add to her efficiency.

GOUBET.

This little boat, described in No. VIII, page 454, has also been quite successful. The following extracts from reports published in French newspapers will show what she has done during the last year:

October 30, 1889.—Went out using her own motive power, though followed by a steam-launch, with which she had telephonic connection. Ran for more than three hours, maintaining perfectly her course and stability in a current, fresh breeze, and rough sea. Although this run was entirely on the surface, the waves washed over the dome continually, so that the conditions were very much as if she were submerged. The new dynamos worked well, going ahead and astern; the batteries gave off no odor or heat, and the temperature was kept at 16° R.

November 16, 1889.—Another and more conclusive trial. Left her moorings, passed between two vessels about 13 feet apart, turned quickly at right angles, and went ahead of one of the vessels through a passage about 11 feet wide, then crossed the harbor and went down to a depth of about 8 feet, and continued the run for an hour, then arose and returned, having been out three hours and fifteen minutes. The crew suffered no inconvenience, and all the mechanism was found to be in perfect order.

January 30, 1890.—Ran for two hours in the open harbor; gave great satisfaction.

February 1, 1890.—Went down to a depth of 1 metre (3.2 feet) and remained there, immovable, for an hour and a half; then descended to a depth of 3 metres and remained four hours and a half.

March 27, 1890.—Concluded experiments showing her ability to torpedo a vessel and to foul a propeller.

[Trials which took place in the harbor of Cherbourg on April 13.]

First experiments.—Five torpedo-boats were anchored close together and ranged side by side. * * * (These boats drew about 5 feet, and the depth of water was 19, so there remained 14 feet beneath their keels.)

The *Goubet*, after making some evolutions at different depths, stationed herself near the rank of torpedo-boats, and perpendicular to their axes; then, without advancing, went down slowly to the proper depth and, avoiding easily the mooring chains, passed quickly and easily the 50 feet occupied by the boats, and came to the surface beyond them. She then turned in her own length, and running just beneath the surface, passed between the anchor-chain of one of the torpedo-boats and its bow; then changing her direction quickly she went quietly under the English steamer *St. Margaret* as if to place a torpedo, and finally returned to her anchorage. The total time of submersion was about forty-five minutes.

Second experiments (afternoon of the same day).—A raft was moored in the middle of the harbor to four anchors; on one side of it a movable propeller was attached, and on the opposite side a pole carrying a flag, was held down by a wire against a system of counter-weights. Finally several small buoys were placed in the harbor about 160 feet apart and held below the surface by wires. The positions of some of these buoys were marked by small flags, but the others were completely concealed. * * *

The water which had been clear during the forenoon was now troubled and muddy. However, as soon as these arrangements had been made, the *Goubet*, which had been waiting in the bottom of the basin, arrived, her approach being made evident to the spectators only by the point of her optical tube which appeared from time to time above the surface.

After passing around the raft the torpedo-boat cut the wire holding down the movable pole, and it quickly righted itself.

Continuing her course, she passed to the other side of the raft and placed an iron bar between the arms of the propeller; then, returning, passed under the raft (avoiding easily the four mooring chains, in spite of their proximity to each other), and left there a dummy torpedo weighing 224 pounds. Finally, quitting the raft, she went in search of the little torpedoes (buoys), intending to cut their wires.

She ran to each of them in succession, looking carefully for the wires, and if not certain of having cut them the first time, returned and recommenced the operation. After two hours and a half of different evolutions (all the buoys having been freed from their attachments) the *Goubet* returned to the surface and the trial ended. * * *

It was then proved by actual experiments that the propeller which had been fouled was rendered immovable by the iron bar.

The optical tube which is used by the *Goubet* appears to be similar to that described above as the "periscope" of the *Gymnote.*

When in action the top of this tube appears on the surface of the water like a kind of float or small buoy, and if the sea is a little rough it becomes impossible to see it. The sighting apparatus does not, therefore, compromise the safety of the submarine boat by betraying her presence to the enemy.

The following notes concerning the *Goubet* are taken from French publications:

* * * The bronze hull will resist a pressure of 6,000,000 kilograms, thus enabling the boat to descend to a depth of about 100 meters (328 feet). * * * An optical tube which passes through the top or cap of the turret, enables the pilot, when this turret is just below the surface, to look out over the water. Having obtained his di-

rection (course) he transfers it to a compass card and then sinks again. The ports in the sides of the turret enable the navigator to see objects outside of the boat before approaching them too near for safety. * * *

Then follows a study (1) of the nautical qualities of the *Goubet* and (2) her means of attack, when acting as a torpedo-boat.

(1) *The most distinguishing quality of the Goubet is her perfect stability.*

When at the surface or below it the boat is in equilibrium in the midst of the element that surrounds her. She descends and rises always vertically, and whenever the introduction or expulsion of the water-ballast is stopped she remains immovable. As we shall see, this point is of the first importance.

The boat being in equilibrium, very little force is required to set her in motion, which explains how a mass weighing 6 tons is so easily handled by one man.

Should the boat touch an obstacle, her momentum being nothing, she would rebound, and would not be injured.

Her speed is only that which is given by the propeller, and this speed can be so little as to be hardly perceptible.

For the same reason any change in the weight of the boat causes her to rise or descend with great rapidity.

* * * * * * *

Then follows a description of the trials.

* * * * * * *

To show the value of these experiments (cutting the wires of buoys, etc.) it is necessary to point out their extraordinary difficulty.

Any boat attempting such work should be able to direct her course without error, and also to stop quickly and remain immovable.

An ordinary vessel attempting to cut a perpendicular wire at the surface of the sea would carry so much way and be so unstable that even under the most favorable circumstances she would probably fail nine times out of ten.

The *Goubet*, on the contrary, being always in equilibrium, the slightest movement of an oar gives her steerage way without causing her to overrun the mark.

* * * * * * *

The above trials demonstrate victoriously that the *Goubet* can direct her course with absolute precision, and approach an enemy without fear of detection. * * *

They also show that she possesses some remarkable nautical qualities which are not possessed in a like degree by any other boat, sub-marine or not, perfect stability and assured direction under all conditions and at all speeds.

* * * * * * *

(2) *Means of attack when acting as a torpedo-boat.*

The *Goubet* having received an order to torpedo a ship, manoeuvres in the following manner:

Supposing the pilot finds himself at a great distance from the armor-clad to be attacked,—he runs at the surface with the turret just showing above water; in this position he has an extended field of view. When so near the enemy that he fears being seen, he sinks until nothing remains above water but the extremity of the optical tube.

It will now be extremely difficult for the battle-ship to recognize the approach of her enemy, especially as the least roughness of the water will prevent the tube being visible except at long intervals.

Until within 300 feet of the vessel the run has been made with the machinery, but from this moment the torpedo-boat is propelled and guided by hand-power.

When within 150 feet the pilot exactly notes the direction of the enemy on his compass card, quickly takes in the tube, and sinks to a depth of from 15 to 25 feet.

It is at this depth that he approaches the ship, choosing his point of attack.

When in position he detaches the torpedo and then retreats with all the speed of his machinery, until he is informed by the wire that he is beyond the dangerous zone; he then closes the circuit.

* * * * * * *

We thus have an engine invisible, invulnerable, obeying faithfully the will of man, and having the power to avoid nets or other defenses.

* * * * * * *

It is not thought that the rôle of a torpedo-boat will be successfully taken by submarine boats of the *Goubet* type in time of war, as the conditions do not permit their carrying a sufficiently powerful torpedo to seriously injure a modern vessel having double bottom, water-tight compartments and powerful pumps.

Moreover, in future wars, ships will rarely anchor on the coast of an enemy, and if they should do so, will always be surrounded by nets which will stop the *Goubet* even more easily than they do a Whitehead torpedo. (?)

But on the other hand this boat ought to render good service in offensive warfare by destroying fixed torpedoes, and cutting their wires and chains. The first care of a squadron operating on an enemy's coast would be to destroy these dangerous engines, and a submarine boat could perform the duty without attracting attention.

It is in this direction that they are about to test the *Goubet*, and if the results are judged satisfactory we should not hesitate to furnish each "unit-of-combat" with one of these movable counter-mines.

ITALY.

It is stated that the Italian authorities have decided on adopting three principal types in the construction of new vessels:

(1) A first-class battle-ship of about 14,000 tons.
(2) A first-class battle-ship of about 8,000 tons.
(3) A cruiser of 4,000 tons.

This last vessel is to be of a type entirely new, and all of them will differ in important particulars from ships of the same tonnage already in the service; the intention being to give them the greatest possible speed and gun-power.

The Budget for 1890–'91 provides $6,680,000 to continue work on vessels already in course of construction and to commence new ships.

VESSELS PROPOSED OR LAID DOWN.

BATTLE-SHIPS C, Q, R.

One of these vessels (C) is now in course of construction at Castellamare, and the other two will be laid down after July 1, 1890.

PROTECTED CRUISERS D, E, F.

All to be commenced before July 1, 1890.

SUPPLY VESSELS G, H.

To be commenced before July 1, 1890. They will have 776 tons displacement and 1,200 I. H. P., and will cost about $138,400 apiece.

TORPEDO VESSELS I, J, K, L, M, N, O, P.

Will resemble the *Partenope* and displace from 800 to 900 tons. It is said that they are to be designed for a speed of 24 knots.

I, J, K, L to be commenced before, and M, N, O, P after, July 1, 1890.

TORPEDO-BOATS.

Sixteen of the Schichau type were ordered in February, 1890; to be built by Pattison, Odero, Cravero, and Ansaldo; four by each firm.

VESSELS LAUNCHED.

PARTENOPE.

This torpedo vessel was launched at Castellamare in November, 1889; she is of the improved *Tripoli* type, described in No. VIII, page 343, and is expected to make 20 knots.

STEAM TRIALS.

FIERAMOSCA.

A protected cruiser of 3,540 tons displacement (page 263, No. VI) had preliminary trials at Leghorn in January of this year with the following satisfactory results: Speed with natural draft, 15.6 knots; with forced draft, 17.5.

The official trials took place in February with slightly better results, and later the contractors gave her a trial on their own account, during which "she made 18.6 knots without difficulty."

As the Government had only stipulated for 17 knots, they have good reason to be satisfied with these performances.

VOLTURNO.

An unprotected cruiser of 1,056 tons (page 264, No. VI), completed in the summer of 1889, had her speed trials at Venice in January, 1890.

She failed to make the 15 knots required, and they are about to change her propeller.

PARTENOPE.

Has terminated the trials of her engines with the following satisfactory results: In a run of three hours with forced draft, 4,150 to 4,200 I. H. P. was obtained with a speed of 22 knots. During a run of twenty-four hours with natural draft, the force developed was 2,200 to 2,300 I. H. P. The engines worked perfectly and the ship was easily manœuvred.

ANDREA DORIA.

This 11,000-ton battle-ship commenced trials in February, 1890.

She is said to have made 15 knots with eight boilers; but her forced-draft trials were unsatisfactory owing to the priming of her boilers. The defect is to be remedied and the trials repeated.

RUSSIA.

The Russian Budget for 1890 is $30,962,906, of which $11,060,756 is to be devoted to new construction.

VESSELS PROPOSED OR LAID DOWN.

NAVARIN.

A turreted battle-ship of 9,500 tons (page 352, No. VIII) was laid down at the Franco-Russian Works, St. Petersburg, in 1889, and will probably be ready for launching in May, 1891.

She is to have 9,000 I. H. P. and 16 knots speed. Battery: Four 12-inch, eight 6-inch, and ten R. F. G.

III SAINTS.

This vessel, the second of the new Black Sea battle-ships, was laid down in July, 1889, at Sebastopol, and will probably be ready for service in three or four years. Two others are projected.

The name of this ship is reported to have been changed to *St. George the Victorious.*

RURIK.

A partly belted distant-service cruiser, of about 10,900 tons, was commenced last year at the Baltic Works, St. Petersburg, but the work has been delayed pending a discussion of new plans. Probable dimensions: Length 426 feet; breadth, 67 feet; depth, 26 feet. Armor: Belt, 10 inches thick above water line and 5 inches below. Armament: Four 8-inch B. L. R. and sixteen 6-inch R. F. G. I. H. P. to be 13,250 and speed 18 knots. Steaming radius, 20,000 miles.

They were about to commence a new 10,000-ton battle-ship at the Baltic Works in February, 1890.

It is reported (April, 1890) that two battle-ships of at least 10,000-tons displacement are to be constructed in England.

CRUISERS—UNPROTECTED.

Four cruisers of the *Donetz* class (1,224 tons) are in course of construction. They are intended for cruising in the Black Sea only, and, with a view to eventual operations in the Danube, their draught is light.

One or two more vessels of the *Pamyat Merkuria* class (3,000-ton unprotected cruiser) will be built or purchased—probably to be used as mine-carrying vessels.

STEAM TRIALS.

SINOPE.

This battle ship (page 268, No. VI) had trials in the Black Sea during the spring of 1890, which were considered very satisfactory.

The speed was 17.85 knots with 12,750 I. H. P., being 150 in excess of the contract, and the consumption of 1.35 pounds of coal per I. H. P. per hour was considerably less than stipulated. Messrs. Napier & Co., of Glasgow, supplied the machinery.

OREL.

A new auxiliary cruiser of about 5,000 tons displacement, built at Glasgow for the Russian fleet, has had natural draft trials with remarkably good results. The run lasted six hours and was made over the measured mile on the Tyne. A speed of 18.88 knots was obtained against the tide and 19.86 with it, giving a mean of 19.37. Trials under forced draft were not made as the above results were deemed sufficiently satisfactory.

It is stated that these results have never been obtained before with natural draft, and above all during a period of six hours.

TORPEDO-BOATS.

Six first-class boats are building (October, 1889), four at Abo and St. Petersburg, for use in the Baltic, and two at Odessa for the Black Sea fleet (page 447, No. VIII), to be completed sixteen months after receipt of the final hull drawings. The Odessa boats will have 81 tons displacement and 1,100 I. H. P.

Schichau has constructed during the last year a torpedo vessel, the *Kazarski*, and two torpedo-boats, the *Adler* and *Anacria*. All three of these were reported ready for trial last October.

Kazarski.—Length 190 feet 3 inches; beam 24 feet 7 inches; displacement about 400 tons. Engines: triple expansion, about 3,500 I. H. P. Two locomotive boilers supply steam at 12 atmospheres of pressure, and work with Schichau's forced draft arrangement. On the three hours' continuous trial with the boat fully equipped, all weights on board, and coal-bunkers full (95 tons), the contract speed of 21 knots per hour was easily maintained without greatly forcing the engines.

Anacria.—Length 128 feet; beam 19 feet 8 inches; displacement about 85 tons. The principal difference between her and the boats previously supplied by Schichau to the Russian navy consists in the more powerful engines, and consequently greater speed. With former boats a speed of 19 knots was guaranteed. But the *Anacria* was built under a guarantee of 21 knots, and the speed was easily maintained during the two hours' trial.

Adler.—This torpedo dispatch boat belongs to a new type introduced by Mr. Schichau, and is similar in principle to the boats built for the Italian navy of the *Aquila* type. She is a twin-screw boat of 152 feet 7 inches length; 17 feet beam, and about 150 tons displacement. Engines of about 2,300 I. H. P. Locomotive boilers. The speed guaranteed was 26.5 knots per hour during a two hours continuous run, and the mean speed obtained during two hours was 26.55 knots. The Russian government therefore, possesses in this steamer one of the fastest vessels in the world.

Two torpedo-boats, the *Nargen* and *Hochland*, were completed at Abo in May, 1890. They are 152 feet long, 16 feet beam, and 7.5 feet draught, and are expected to make 22 knots.

GERMANY.

VESSELS PROPOSED OR LAID DOWN.

BATTLE-SHIPS.

Of the four battle-ships mentioned in No. VIII, page 354, the order has been given to the Germania Works at Gaarden near Kiel, to commence one; and the others are to be built, one by the Government at Wilhelmshaven, and two by the Vulcan Iron Works at Stettin. They are to have 10,000 tons displacement, and 15,000 I. H. P.

There will be delay in the completion of the new armored vessels, owing to the fact that the German manufacturers have found it impossible to fulfill the orders for armor-plating on time. They have been authorized by the Admiralty to negotiate with Messrs. Brown & Co., of England, for assistance in the work. This will delay the vessels now on the stocks until the spring or summer of 1894.

ARMORED COAST-DEFENSE VESSELS.

Ten of this class are provided for. One is already launched, two are to be commenced this year at the Weser Works, Bremen, and all are to be finished by 1895. For description see "Vessels launched, *Siegfried*."

FIRST-CLASS PROTECTED CRUISERS.

Eight are provided for (page 354, No. VIII) of the *Irene* type, but faster and with better protection and armament. One is in course of construction at Kiel, three more will be laid down in 1890, and they are all to be completed by 1895.

Dimensions: 328.1 feet long; 49.2 feet beam; 22.9 feet draught; 5,500 tons displacement.

Battery: Two 24-centimetre (9.4 inch), eight 15-centimetre (4.9 inch), and a number of R. F. G.

Engines: 12,000 I. H. P., expected to give 20 knots speed.

Estimated cost: $1,440,000 apiece.

UNPROTECTED CRUISERS.

Fourteen vessels of the *Schwalbe* class, described in No. VII, page 316, are provided for. All to be completed by 1895.

TORPEDO VESSELS.

Two building and two more to be commenced this year. See description of torpedo catcher, *Meteor* (F), under head of "Vessels launched."

It is reported that these vessels are to be named *Castor*, *Pollux*, *Sirius*, and *Vega*, and that others of the same class are also to be named after fixed stars.

MINE VESSEL.

To be used in the transportation and laying of submarine mines; is building at Wilhelmshaven and will be launched in the spring.

DYNAMITE GUN VESSEL.

It is reported (April, 1890) that the Vulcan Company, of Stettin, have received an order to build a vessel similar to the American *Vesuvius*. She is to carry three pneumatic dynamite guns of 11 and 12 inch calibre.

VESSELS LAUNCHED.

SIEGFRIED.

The first of ten armored coast-defense vessels (page 354, No. VIII) was launched in August, 1889, and will probably be completed this year.

These vessels having considerable beam and but moderate draught, are well fitted to manœuvre in the rivers and bays of a coast, but they are also intended to fight at sea, and their bow guns are, therefore, carried high enough to be handled in rough weather.

Their armament will be three 24-centimetre (9.4-inch) B. L. in armored barbettes, two forward and one aft; six R. F. G. and four torpedo tubes. Turret armor, 9.4 inches thick; side armor, 8 to 12 inches. Dimensions: Length, 239.6 feet; beam, 45.9 feet; draught, 17.7 feet; displacement, 3,800 tons. Estimated speed, 18 knots.

METEOR (F).

A torpedo vessel of about 950 tons displacement and 5,000 I. H. P. was launched at Gaarden, near Kiel, on January 20, 1890.

She is to have a battery of R. F. G. and three torpedo tubes, and is expected to be very fast. (See Steam trials.)

STEAM TRIALS.

METEOR.

It was expected that this torpedo vessel would make 23 knots, but trials which took place in April showed that her hull was too weak for the machinery. They were obliged to stop at 18 knots on account of excessive vibration.

TORPEDO BOATS.

During the current year Schichau has delivered some of the last lot of sixteen torpedo boats ordered (page 444, No. VIII), and is still building the others. Probably eight will have 110 tons displacement and 1,400 I. H. P., and the remainder, 130 tons displacement and 2,500 I. H. P. They will be expected to make 23 and 25 knots respectively.

The two division boats building will be known as No. 9 and No. 10, that being the number of this class fit for immediate service.

All the old boats worth the change, and all the new Schichau boats, will be uniformly fitted with one bow tube and two deck tubes on circular mounts. The stems of the new boats are to be perfectly straight with no projections.

It is announced at Kiel that one of the submarine torpedo-boats constructed by the Howaldt works has given very satisfactory results. The boat is intended to run either at the surface or beneath it, and has made 16.5 knots in the first case and 9.5 in the second. They estimate that she can run for two hours under water at a depth of from 10 to 30 feet.

Three other submarine boats which are being tried were built by the Government.

SPAIN.

VESSELS PROPOSED OR LAID DOWN.

ARMORED CRUISERS.

Of the six belted cruisers described in Nos. VII and VIII, three, the *Infanta Maria Teresa*, *Viscaya*, and *Almirante Oquendo* were laid down at Bilboa in June, July, and October, 1889.

The other three are to be built at Cadiz, Ferrol, and Cartagena by the Government.

TORPEDO VESSELS.

Six of this class are in course of construction. The *Audaz*, *Temerario*, and *Nueva España* have been launched during the last year.

The other three are named *Rápido*, *Galicia*, and *Veloz*. (Pages 319, No. VII, and 270, No. VI.)

VESSELS LAUNCHED.

TEMERARIO—NUEVA ESPAÑA—AUDAZ.

The first of these torpedo vessels was launched in October, 1889, the second in November, and the third since January, 1, 1890.

The *Temerario* displaces 571 tons, and is fitted with two bow torpedo-tubes, and a battery of two 12-centimeter (4.72-inch) Hontorias and five R. F. G. Engines of 2,600 I. H. P. are expected to give 18 knots speed.

The remaining vessels of this class are reported as being similar to the above.

MARQUES DE LA ENSENADA.

A steel cruiser of the same type as the *Isla de Cuba* (pages 272, No. VI, and 321, No. VII), was commenced on July 24, 1887, and launched in February, 1890.

She will carry six 12-centimeter (4.72-inch) R. F. G., eight light R. F. G. and three torpedo-tubes. Displacement, 1,030; I. H. P., 1,600.

SUBMARINE TORPEDO-BOAT "PERAL."

The following accounts of the performances of this boat, taken from Spanish newspapers, will show that she has had a number of trials during the past year, and that she is, to all appearances, a decided success.

In a trial that took place in the spring of 1889, it seems that a slight accident occurred to the accumulators, and some papers magnified it into a serious disaster, saying that the crew had to jump overboard, etc., but this has been positively denied by Lieutenant Peral.

[Extracts from newspapers.]

July 17, 1889.—The boat had a surface trial. She obeyed exactly every movement of the helm, turning and changing her course with rapidity and precision. She ran during the two and a half hours a distance of 16 miles from start to finish, having attained a speed of 8 knots with the use of only half of the batteries.

On her return to the arsenal it was observed that the electric power consumed was insignificant. The electro-motive force used was 240 volts and 30 ampéres, with no change in the intensity of the current.

The boat avoided vessels at anchor in the harbor with great ease, and it was plain that the proof of her speed and manœuvring ability could not be more conclusive.

July 26—Twelve persons were hermetically sealed up in the boat and remained there for three hours without inconvenience.

August 1.—On this day commenced a series of submersion trials, which took place in dock at the Cadiz Arsenal.

At 7.30 p. m. officers and crew entered and hermetically closed the boat. Telephonic communication was maintained with the interior.

Boat was slowly submerged until nothing remained above water but the turret, and remained so for from seven to ten minutes.

August 2.—This time the boat went down as far as the middle of the turret, everything working well and verifying Lieutenant Peral's calculations.

August 3.—The boat was submerged a little more than before, only about one-quarter of the turret remaining above water. While beneath the surface she was made to move ahead and astern.

August 4.—Engaged in calking the upper works, which had leaked somewhat during the trials.

August 5.—She went down and came up with admirable precision. When under water nothing was visible but the pennant flying from the top of the turret.

August 7.—Went down again, keeping her trim perfectly while descending and ascending.

August 8.—A repetition of the above with brilliant results.

From the 8th to the 25th.—Trials of torpedoes, launching apparatus, and electric motors.

August 26.—The trials carried out to-day in the Bay of Cadiz by Peral lasted more than four hours, and were held under such conditions as to clearly prove the value of his work. The sea was slightly rough, and covered with a multitude of sail-boats and steam-launches, which gave the steering qualities of the submarine boat a severe test. She ran at a mean speed of over 6 knots. Had torpedo practice, with good results.

September 3 *and* 4.—Had successful sea trials; verified turning power and speed on the surface, and launched torpedoes at distances of from 300 to 500 metres. A slight accident to the air valve compelled a return to the dock. While in dock this time the horizontal propellers were changed for others of smaller diameter.

November 18 *to* 22.—Had successful dock trials, diving and rising quickly, keeping trim well, etc.

December 2.—The boat ran on the surface for 16 miles in two hours, using only half the accummulators, and from this it is calculated that she will attain 11 knots with full power.

At 1.56 she went under, running at full speed, and remained there until 2.05, making a distance of about a mile. Then went down again, etc.

Señor Juan Carbo, an engineer, thus sums up the essential points of this trial:

The *Peral* navigated three hours and thirty minutes, completely cut off from all communication with the outer air, and more than two hours in situation of combat, with only a tenth of the turret above water; for forty minutes she was completely submerged, in which time she ran 4 miles. The total distance run in the seven hours, above and below the surface, was 22 miles.

The same official thus describes the manner of handling the boat in action.

In war time the *Peral* can be run at a depth of 7½ feet, the ports of the observation tower being then just above water. In this situation the commander can observe, with clearness the vessel to be attacked, and when he judges it convenient he can quickly descend until nothing is above water but the extremity of the optical apparatus. The boat's draught under these circumstances will be 11 feet. This is the last position for attack, although it is possible to disappear completely.

The last trials prove that the boat has power to manœuvre in the sea for six or seven hours.

December 5.—The *Peral* went down until the ports below the sighting tower were covered, and ran in this condition for more than an hour. Fired torpedoes successfully.

December 17.—At 10.30 a. m. the boat was submerged as far as the turret. At 11.30 she went under completely. At 12 she was submerged to the base of the turret; from then until one, almost totally. From 1.30 to 2.30 she ran submerged to the middle of the turret, and afterwards she was completely covered. The speed made under water was about 6 knots.

The proofs guarantee a complete triumph for the inventor and exactly justify all his calculations.

December 25.—While running at the rate of seven knots, the boat went down to a depth of 29½ feet (9 metres), and navigated thus for more than sixteen minutes, coming to the surface without slowing down. Then went down and ran twenty minutes.

The distance run below water during the whole trial, as calculated by Peral, was more than four miles, and he believes that it has solved the problem as to the ease with which the depth of submersion can be regulated.

In his report he says "the boat maintained herself at the exact depth desired without an error of more than two or three decimetres, remaining under water twenty minutes."

Lieutenant Peral has proposed to the Spanish Government that a small fleet of five such boats for coast defense shall be built at Carraca.

They would be larger than the *Peral*, a new kind of steel would be employed, the form of the accumulators would be improved, and an apparatus of new design used to preserve the glass from weed and other impurities which impede vision when the present boat is submerged.

AUSTRIA.

VESSELS PROPOSED OR LAID DOWN.

A small single-turreted monitor for use in the Danube River, is provided for in the budget of 1889–'90, and it is reported that three others are to be built.

A protected cruiser (*C*) (page 357, No. VIII), now in course of construction, will be larger than the *Franz Josef*, and have more complete protection. She will have a displacement of 5,200 tons.

TRABANT.

The keel of this torpedo vessel (page 357, No. VIII) was laid in July, 1889, by the Stabilimento Technico, at San Rocco. She is similar to the *Planet*, and carries the same battery, but is larger, displacing 546 tons instead of 480.

The contract stipulates that she shall maintain a speed of 20.5 knots for four hours, and that the price paid for the ship, boilers and machinery shall be 375,000 florins (about $150,000).

The Yarrow Ship-building Company has received an order from the Austrian Government to build a steel torpedo vessel of a new type, specially designed for great speed.

The engines are to be of 3,500 I. H. P. and the minimum speed is to be 22 knots. (January, 1890.)

STEAM TRIALS.

FRANZ JOSEF.

First class protected cruiser (page 357, No. VIII); has had a trial in which she made 16 knots with 80 revolutions: it is expected that she will make 19 knots with full power. On March 1, 1890, a satisfactory trial gave 18.5 knots.

PRINCESS IMPERIAL STEPHANIE—CROWN PRINCE RUDOLF.

These two battle-ships (page 274, No. VI) had their speed trials in October, 1889.

The *Stephanie* made 15.6 knots with natural draft, and 16.3 with forced draft.

The *Rudolf* made a maximum speed of 15.7 knots, and a mean of 15.48 knots during a three-hour trial.

PLANET.

A torpedo vessel described on page 358, No. VIII, has had speed trials which did not give satisfaction. It is said that she only made 19 knots instead of the 20.5 required, and that alterations are to be made before she is accepted.

TORPEDO-BOATS.

The five first-class boats of the Schichau type, mentioned on page 438, No. VIII, as building at Trieste, were all completed during 1889, and Austria now possesses twenty-one of this type (83 tons displacement).

In addition to the above there are twenty-seven Yarrow boats, two being of the first class with 88 tons displacement, and twenty-five of the second class of 48 to 57 tons.

Seventeen of the second-class boats were built at Pola, and the remainder in England. There are also two Thornycroft and six Yarrow third class boats of about 28 tons displacement, making a total of 56 boats of all classes.

It was reported in March that preparations were being made to build five 56-ton boats of the Schichau type.

CHILI.

VESSELS PROPOSED OR LAID DOWN.

PRESIDENTE PINTO—PRESIDENTE ERRAZURIS.

Protected cruisers described in No. VIII, page 359, were laid down in the summer of 1889, at La Seyne, France.

VESSELS LAUNCHED.

ALMIRANTE LYNCH—ALMIRANTE CONDELL.

Torpedo vessels of the Sharpshooter type, were launched by Laird Brothers, at Birkenhead, in February and March, 1890.

Their dimensions are; length, 240 feet; beam, 27.5 feet, maximum draught, 9 to 10 feet. They are divided into 38 water-tight compartments, a central bulkhead separating the two engine-rooms and the two sets of boilers.

The machinery space is protected by steel bulkheads, extending from bilge to gunwale and forming the coal bunkers. Two pair of triple-expansion engines give 4,500 I. H. P., and an estimated speed of 21 knots.

Battery: Three Hotchkiss 14-pdr. R. F. G., two on the forecastle and one aft; four 3-pdr. H. R. C., and two Gatlings. Five torpedo-tubes are fitted; one in the bow, and four on broadside.

These vessels have good freeboard at the ends; a high platform for the bow and stern guns being secured by a top-gallant forecastle and half poop, which give ample space for the accommodation of officers and men.

DENMARK.

The naval programme contemplates the formation of two squadrons consisting each of four armor-clads, two cruisers of the *Valkyrien* type, two of the *Geiser* type, and twenty torpedo boats.

The new third-class cruiser building at Copenhagen (page 323, No. VII) is to be called the Hekle. She is to be ready for trial by the autumn of the current year.

VESSELS PROPOSED OR LAID DOWN.

GEISER.

A cruiser of the *Hekla* type (page 323, No. VII) is to be built by Messrs. Wain & Burmeister, of Copenhagen; and a third of the same type is projected.

They are expected to cost about $378,000 apiece.

STEAM TRIALS.

The partially-protected steel cruiser *Valkyrien* (page 276, No. VI) has given great satisfaction on trials that took place November 30, 1889, the 5,300 I. H. P. and 17.5 knots speed obtained being 300 H. P. and half a knot more than required. The consumption of coal was also considerably smaller than stipulated.

Her natural-draft trial that took place on the 13th of the same month gave 15.5 knots.

Estimated cost of the vessel, 3,500,000 Danish crowns—about $945,000.

TORPEDO-BOATS.

A first-class boat, the *Springeren*, is provided for in the recent Budget and is to be laid down this year; if she prove a success two more of the same type will be built.

The two second-class boats built by Thornycroft and delivered at Copenhagen in 1889 have the following dimensions: Length, 77.7 feet; beam, 8.9 feet; displacement, 25 tons.

Their engines are to develop 380 I. H. P. and give a speed of about 17 knots.

Two torpedo-tubes are fitted, one on each bow, and the battery consists of one single-barrel 37-millimetre R. C.

GREECE.

VESSELS PROPOSED OR LAID DOWN.

The contracts for two first-class cruisers were given to the Forges et Chantiers de la Méditerranée in April, 1890.

VESSELS LAUNCHED.

SPETSIA—PSARA.

The two battle-ships building at Graville have been named *Spetsia* and *Psara.*

The *Spetsia* was launched October 26, 1889, and the *Psara* on February 20, 1890. They are sister ships to the *Hydra* described on page 360 of No. VIII. Length, 334 feet; beam, 51 feet 10 inches; displacement, 4,885 tons.

HOLLAND.

In the Budget of 1890 the ship-building programme calls for 700,000 florins for the continuation of two armored ships now on the ways. The Minister of Marine proposes the building of one large torpedo-boat, one of smaller dimensions, and one torpedo catcher, the number of the latter to be successively increased to six; to have 20 knots speed, and to be armed with 75-millimetre and 47-millimetre R. F. G. and one under-water tube. The total Budget asks for 14,210,237 florins.

VESSELS LAUNCHED.

A gun-boat named the *Dolfijn* was launched in 1889.

Displacement, 250 tons; I. H. P., 375; speed, 12 knots; length, 118 feet; beam, 19.7 feet.

TORPEDO-BOATS.

It is proposed by the government to increase the number of torpedo-boats to 50, of which 26 are to be first-class.

Two second-class boats have been added to the list during the last year and two deep-sea boats are building.

JAPAN.

VESSELS PROPOSED OR LAID DOWN.

OSHIMA—AKITSUSHIMA—AKUTSIMA.

In June, 1889, two cruisers were laid down in Japanese dock-yards; the *Oshima*, at Yokosuka, and the *Akitsushima*, at Onohama.

The *Akutsima*, a cruiser similar to the English "Medea," was laid down at Yokosuka early in 1890.

It is reported that two armored coast-defense vessels were ordered in Europe during January of this year.

VESSELS LAUNCHED.

ITSUKUSIMA—MATSUSHIMA.

Coast-defense vessels, of about 4,300 tons displacement, were launched at La Seyne, France; the former on July 18, 1889, and the latter on January 22, 1890. (For description, see page 278, No. VI.)

STEAM TRIALS.

YAEYAMA.

A dispatch and torpedo supply-vessel, has given great satisfaction; and has been accepted by the authorities, without the year's guarantee, which the engine contractors expected to give.

On a three hours' trial, under forced draft, the maximum speed was 21.5 knots, and the mean 20.75. The engines were cool, and there was but little vibration. The maximum I. H. P. was 6,076, and the mean 5,630; revolutions, 172.

Her natural draft speed is said to be 18 knots, and her cruising speed 13.

This vessel was built at the Yokosuka dock-yard, but her engines were supplied by Hawthorne & Leslie, of England. They are of the horizontal, direct-acting, triple-expansion type, and are supplied by six cylindrical steel boilers.

A half-inch protective deck covers engines and boilers, and her guns are protected by shields.

NORWAY.

VESSELS PROPOSED OR LAID DOWN.

VIKING.

A first-class gun-boat laid down in 1889, is described as follows: To be built of steel with a complete protective deck 1.4 inches thick; cellular compartments, and longitudinal and transverse bulkheads. Dimensions: length, 196 feet, 10 inches; beam, 30 feet, 6 inches; mean draught, 12 feet; displacement, 1,113 tons. Armament: two 6-inch B. L., Krupp, 40 calibre, one forward and one aft; four 65-millimetre R. F. G., and six 37-millimetre R. C. Triple-expansion engines; twin screws, three-bladed and of cast steel; cylindrical boilers.

SWEDEN.

VESSELS PROPOSED OR LAID DOWN.

The Government has asked Parliament for the following extraordinary grants for the Navy: $235,000 as a first grant for a new iron-clad, the total cost of which is calculated at $775,000. She is to be the same type as the *Svea*, described in No. V, page 212, only somewhat narrower and longer, with increased power and higher speed. A further $134,000 is asked for the completion of the *Göta*, a similar ship, and $66,000 for a new second-class gun-boat, different from those built in 1863, twenty feet longer, and armed with high-power R. F. G.

VESSELS LAUNCHED.

The iron-clad *Göta*, Sept. 30, '89. (For description, see No. VII, page 325.)

PORTUGAL.

A royal decree was issued March 20, 1890, concerning the reorganization of the navy to the following effect:

ART. 1. The Portuguese navy is to consist of the following ships:

4 armored coast-defense vessels.
10 protected cruisers of 3,400 to 4,500 tons, with a speed of at least 20 knots.
18 gun-boats of the first class, of 600 tons.
12 harbor gun-boats of 150 to 300 tons.
2 steam transports of 3,500 tons.
1 sailing school-ship.
24 torpedo boats.

ART. 2. The government, within the limits of an annual fund that will be voted by parliament, will proceed with the following transformation and construction: 1st, the transforming of the armor-clad *Vasco-da-Gama* and the transport *India;* 2d, the acquisition of 3 coast-defense vessels, 6 protected cruisers, 2 gun-boats of the first-class, 6 harbor gun-boats, 1 sailing school-ship, and 20 torpedo-boats.

ART. 3. The number and class of ships to be kept in commission and in reserve will be fixed by decree.

ART. 4. All laws conflicting with the present one are hereby rescinded.

The Minister of Marine in presenting the decree to the King, submitted a statement of the conditions which governed the new naval policy, as follows: The protection of the coast against blockade and bombardment; the control of a force able to prevent military operations in the Tagus, and the possession of ships of sufficient power to injure the commerce of nations more powerful than Portugal.

Concerning the type of armored ship required, he observed that Portugal had not the means of providing great battle-ships, and, therefore, those of moderate dimensions, carrying 32 centimetre guns, would be procured. Such ships assisted by torpedo boats would efficiently defend the capital, and could, by reason of their light draught, cruise in the Tagus and its tributaries.

For the cruiser type the *Piemonte* and *Blake* were examined. Both were desirable because of their great speed, but the *Piemonte* had not sufficient coal capacity and her engines were too light, and the size of the *Blake* was too large. Therefore, a ship between 3,400 and 4,500 tons was selected. Since the offensive warfare was to be given to these cruisers it would be necessary to establish more fortified supply-stations in distant seas, those already possessed being insufficient.

After these general considerations he discussed Articles 1 and 2 of the decree. He considered that the four armored coast-defense vessels assisted by torpedo boats would be a sufficient defense for Lisbon. The cruisers should be sent; two to the Azores, one to Angola, one to South America, two to the east coast of Africa, and one to China; the remaining four to be kept at Lisbon, either in commission or ready to be commissioned. The eighteen first-class gun-boats should be for colonial service and the assistance of the cruisers. The twelve harbor gun-boats should be given the policing of the coasts and the fisheries. The two transports were necessary to maintain communication with the colonies. The sailing ship was needed as a school-ship; and, finally, the twenty-four torpedo-boats would be indispensable as aids to the armored ships, and as defenders of those parts of the Portuguese coast which are difficult of access.

In conclusion the Minister stated that in pursuit of the above programme the *Vasco da Gama* should have her casemates replaced by turrets carrying heavier guns, and be provided with a submarine armament and search lights, and that the three new armored ships should be of a more powerful type: that four cruisers had already been ordered since February, leaving six to be provided, which should be of the latest design and highest attainable speed: that twelve of the first-class gun-boats were actually in service; one, the *Diu*, was fitting out; one, the *D. Luiz I*, was building, and two others were soon to be added to the list: that three of the second-class gun-boats were off Angola and Mozambique; one was building for East Africa, and two had been contracted for, leaving but six to be provided: that one transport, the *Africa* was in good condition, but the other, the *India*, would need changes in machinery and internal arrangements; and finally, that as there were but four torpedo-boats, it would be necessary to obtain twenty more.

The report closed by stating that the only other vessels owned by Portugal were the corvettes *Estephania*, *B. Diaz*, *A. de Albuquerque*, *Rainha de Portugal*, *Mindello*, and *Duque da Terceira*. These, while not powerful enough to act as units of combat, might render useful service in re-inforcing the smaller ships destined for colonial service, and in aiding the battle-ships by freeing them from political duties. For the above reasons these vessels should be preserved and repaired.

VESSELS PROPOSED OR LAID DOWN.

Bids were received December 7, 1889, from English, French, and German firms for the construction of two cruisers and two gun-vessels, authorized to be purchased by the Government.

In May of this year the following firms sent in bids for four belted cruisers of about 4,500 tons displacement; Orlando Brothers, of Leghorn, the Forges et Chantiers de la Méditerranée, the Germania Works, of Kiel, and Messrs. Cramp & Sons, of Philadelphia. The contracts will probably be awarded to the successful bidder in June.

Messrs. Yarrow & Co. are building six light-draught stern-wheel gunboats for use in the Zambezi River. When they are completed the Portuguese will have nine of this class.

Five torpedo-boats have been ordered from Schichau of Elbing.

VESSELS LAUNCHED.

In August, 1889, at the government works, Lisbon, the gun-vessel *Diu*, the first of her type built.

Battery, four 15-centimetres Krupp and six light R. F. G. and R. C. Her hull is teak with steel frames; barkentine rig; length, 147.6 feet; beam, 26.2 feet; diplacement, 640 tons.

BRAZIL.

VESSEL LAUNCHED.

ALMIRANTE TAMANDARE.

This first-class protected cruiser was launched in March, 1890, at the arsenal of Rio de Janeiro.

She displaces 4,537 tons, and is said to be the largest vessel ever built in Brazil. Her estimated speed is 17 knots, with 7,500 I. H. P. Protective deck, complete, 1.6 inches thick. Battery: ten 4.9-inch (15-centimetre) R. F. G., two 3.9-inch (12-centimetre), R. F. G., ten of smaller calibre, and eight R. C.

ARGENTINE REPUBLIC.

It is reported that the Argentine Government has contracted through its agents in Europe for the construction of the following war-ships: One armor-clad of 7,000 tons; two armor-clads of 2,000 tons; two steel-protected cruisers of 5,000 tons; one steel-protected cruiser of 3,500 tons; two cruisers of 1,800 tons; four torpedo-vessels of 500 tons; and fourteen torpedo-boats of the first and second class. All of these vessels are to be completed by the end of the year 1892.

The *Argentino*, a protected cruiser of about 3,000 tons displacement, has been bought by the Argentine Government from Messrs. Armstrong, Mitchell & Co., of Newcastle. She is to have a maximum speed of 21 knots and be able to steam from Newcastle to Buenos Ayres. Her protective deck is from 1 to 3 inches thick, and all the guns are to be protected by shields.

Her battery consists of six 15-centimetre Krupp R. F. G. and six 12-centimetre of the same system.

VESSELS LAUNCHED.

ESPORA—ROSALES.

On April 22 Messrs. Laird Brothers, of Birkenhead, launched the first of two torpedo-vessels built to order of the Government of the Argentine Confederation. She was christened *Espora*.

The armament consists of Nordenfeldt R. F. G.; two 14-pounders, one on each side of the forecastle, and one 8-pounder and two 3-pounders on the poop; also two Gatlings. Five torpedo-tubes are fitted, one in the bow and two on each broadside, to discharge the new 18-inch Whitehead torpedo.

Dimensions: 210 feet over all; 25 feet beam; about 8 feet draught, and 615 tons displacement. Estimated speed, 20 knots with 3,250 I. H. P.

The second of these vessels was launched on May 7, and is named *Rosales*. She is similar to the *Espora*.

NICOCHEA.

A protected cruiser, the *Nicochea*, was launched on May 5 from the Elswick ship-yard of Messrs. W. Armstrong, Mitchell & Co., Newcastle. It is claimed for this vessel that she combines great speed with great offensive power.

She has no vertical side-armor, but all her vital parts are below the water-line and below a heavy protective deck.

The estimated speed of the *Nicochea* is 22 knots. She is 300 feet long and has 43 feet beam; displacement 3,200 tons; I. H. P. 13,500. Battery: two 21-centimetre (8.3-inch) B. L.; eight 12-centimetre R. F. G., and twenty R. C.

She also possesses strong means for torpedo attack.

TORPEDO BOATS.

Two first-class 110-ton boats were completed in 1889, by Thornycroft for the Argentine Government. Their armament consists of two fixed tubes forward and two movable tubes, one on each side, aft. Two Hotchkiss R. F. G. are mounted, one on top of the forward conning tower and one on a tripod aft.

The first of these boats was launched in May, 1890, and named the *Comodoro Pij.*

The contract calls for 1,400 I. H. P. and 25 knots speed.

The following boats were ordered of Yarrow & Co. in September, 1889, and are now in course of construction:

Six first-class, 127.9 feet long; 13.1 feet beam; 120 tons displacement; 1,150 I. H. P., and 22.5 knots speed.

Eight second-class; 59 feet long; 9.8 feet beam; 15 tons displacement, and 16 knots speed.

TURKEY.

In December, 1889, £84,000 was appropriated for the rebuilding of the four battle-ships *Azazieh*, *Mahmudieh*, *Osmanieh*, and *Orkanieh*. The vessels are to be cut down to the upper deck, and the armor underneath the gun-deck for a space of 138 feet is to be replaced by a 10-inch steel belt. A superstructure 132 feet long is to be faced with 1-inch steel as a protection to the auxiliary battery. The three masts are to be replaced by two military masts. New boilers will give a speed of 14 knots, it is hoped. The old battery is to be replaced by two 26-centimetre B. L. in barbettes, one forward and one aft; eight 15-centimetre Krupp B. L. in broadside; six 10-centimetre R. F. G. on upper deck, and two torpedo-tubes forward. They will each carry a second-class torpedo-boat.

VESSELS PROPOSED OR LAID DOWN.

It is reported (April, 1890) that the Sultan has ordered the laying down of two battle-ships and two cruisers at the arsenal of the Golden Horn. One of the cruisers will be named *Feiz-y-Bahry*.

A composite vessel, ordered to be built at the Imperial dock-yards, Ismid, is thus described: Length, 226 feet; beam, 35 feet; depth, 21.2 feet; draught, 14 feet; displacement, 1,815 tons; I. H. P., 2,500; speed, 14 knots.

Armament: Four 17-centimetre Krupp, six 12-centimetre Krupp, eight 12-centimetre R. F. G., and two launching tubes.

VESSELS LAUNCHED.

HEIBET-NUMIA.

A composite cruiser, designed by Hussin Pasha, was launched from the Imperial dock-yard at Constantinople on January 30, 1890.

Battery: Six 12-centimetre long-range breech-loaders in broadside.

Principal dimensions: Length, 226 feet; beam, 37 feet; depth, 21 feet; displacement 1,958 tons.

The engines are to give 2,784 I. H. P. and 15 knots speed.

MEXICO.

VESSELS PROPOSED OR LAID DOWN.

SCHOOL-SHIP.

The Mexican Government has commissioned the Société des Forges et Chantiers de la Méditerranée to build a steel two-masted vessel of 1,200 tons, capable of steaming 13 knots with natural draft.

The armament will consist of two Canet guns of 12 centimetres (4.72 inches), one forward and the other aft; four Vavasseur 100-pounders, two Nordenfeldt R. F. G. of 2.16 inches, and two 37-millimetre H. R. C.

CHARLES E. FOX,
Lieutenant, U. S. Navy.

II.

NOTES ON MACHINERY.

From the Bureau of Steam Engineering have been obtained the general descriptions of the machinery designed during the past fiscal year.

5,500-*ton protected cruiser*.—The propelling engines will be rights and lefts, placed in water tight compartments and separated by a middle-line bulk-head. These engines will be of the vertical inverted-cylinder, direct-acting, triple-expansion type, each with a high pressure cylinder 42 inches, an intermediate-pressure cylinder 59 inches, and a low-pressure cylinder 92 inches in diameter—the stroke of all pistons being 42 inches. It is estimated that the collective indicated horse-power of propelling, air-pump, and circulating-pump engines should be about 13,500 when the main engines are making about 129 revolutions per minute. The high-pressure cylinder of each engine will be forward and the low-pressure cylinder aft. The main valves will be of the piston type, worked by Stephenson link-motions with double-bar links. The valve-gears of the intermediate-pressure and low-pressure cylinders will be interchangeable. There will be one piston valve for each high-pressure cylinder, two for each intermediate pressure cylinder, and four for each low-pressure cylinder. Each main piston will have one piston rod, with a cross-head working on a slipper-guide. The framing of the engines will consist of cast-steel inverted Y-frames at the back of each cylinder and cylindrical cast-steel columns at the front. The engine bed-plates will be of cast-steel, supported on wrought-steel keelson-plates built in the vessel. The crank shafts will be made in three interchangeable and reversible sections. All shafting will be hollow. The shafts, piston-rods, connecting-rods, and working parts generally will be forged of mild open-hearth steel.

The condensers will be made of composition and sheet-brass. Each main condenser will have a cooling surface of about 9,450 square feet, measured on the outside of the tubes, the water passing through the tubes. For each propelling engine there will be a double, vertical, single-acting air-pump worked by a vertical simple engine. The main circulating-pumps will be of the centrifugal type, two for each condenser, worked independently. The propellers will be right and left, of manganese bronze, or approved equivalent metal.

Each engine-room will have an auxiliary condenser, made of composition and sheet-brass, of sufficient capacity for one-half the auxiliary machinery, each condenser being connected with all the auxiliary machinery. Each of these condensers will have a combined air and circulating-pump.

There will be four double-ended and two single-ended steel boilers of the horizontal return fire-tube type, about 15 feet 3 inches outside diameter and about 21 feet 3 inches and 10 feet 11½ inches long, for the double ended and single-ended boilers, respectively, all constructed for a working pressure of 160 pounds per square inch. They will be placed in four water-tight compartments. There will be two athwart-ship fire-rooms in each of the boiler compartments. Each of the single-ended boilers will have four, and each of the double-ended boilers will have eight corrugated furnace flues, 3 feet 3 inches internal diameter. The total heating surface will be about 28,298.64 square feet, measured on the outer surface of the tubes, and the grate surface 824 square feet. There will be in each fire-room in which the check-valves are placed an approved main and an approved auxiliary feed-pump, and in each engine-room an auxiliary feed-pump. There will be two smoke-pipes.

The forced-draft system will consist of one blower for each fire-room, discharging into an air-tight fire-room. Air-tight bulk-heads will be fitted so as to reduce the space to be maintained under pressure.

There will be steam reversing-gear, ash-hoists, turning-engines, auxiliary pumps, engine-room ventilating-fans, engine for workshop machinery, hydraulic pumping-plant for various purposes, turret turning-engines, a distilling apparatus, and such auxiliary or supplementary machinery, tools, instruments, or apparatus as are described in the detailed specifications.

Gun-boats Nos. 5 and 6.—The propelling engines will be rights and lefts, placed in a common water-tight compartment. These engines will be of the vertical inverted-cylinder, direct-acting, triple-expansion type, each with a high-pressure cylinder 15¾ inches, an intermediate-pressure cylinder 22½ inches, and a low-pressure cylinder 35 inches in diameter; the stroke of all pistons being 24 inches. The collective indicated horse-power of propelling, air-pump, and circulating-pump engines will be 1,600 when the main engines are making about 200 revolutions per minute. The high-pressure cylinder of each engine will be forward and the low-pressure cylinder aft. The main valves will be of the piston type for the high-pressure and intermediate-pressure cylinders, and slide-valves for the low-pressure cylinders, all worked by Stephenson link-motions with double-bar links. The piston-valves, valve-liners, and valve-gears will be made interchangeable. There will be one piston-valve for each high-pressure cylinder, two for each intermediate-pressure cylinder, and one slide-valve for each low-pressure cylinder. Each main piston will have one piston-rod, with a cross-head working on a bar-guide. The framing of the engines will consist of wrought-steel columns, trussed by wrought-steel stays. The engine bed-plates will be of cast-steel, supported on wrought-steel keelson-plates built in the vessels. The crank-shafts will be made in three interchangeable sections. All shafting will be hollow. The shafts, piston-rods, connecting-rods, and working parts generally will be forged of mild open-hearth steel.

The condensers will be made entirely of composition. The main condenser will have a cooling surface of about 2,240 square feet, measured on the outside of the tubes, the water passing through the tubes. There will be a double vertical single-acting air-pump worked by a vertical compound engine. The circulating-pump will be of the centrifugal type, worked independently. The propellers will be right and left, of manganese bronze, or approved equivalent metal.

There will be an auxiliary condenser of sufficient capacity for the auxiliary machinery. The auxiliary condenser will have a combined air and circulating-pump.

There will be two straight-way fire tubular boilers, placed in a common water-tight compartment. The outside diameter of boilers will be about 9 feet 9 inches and the length about 16 feet 10¼ inches over heads. They will be constructed for a working pressure of 160 pounds per square inch. Each of the boilers will have three corrugated furnace flues 3 feet internal diameter. The total heating surface will be about 3,630 square feet, measuring the tubes on the outer surface, and the grate surface 100 square feet. There will be a main feed-pump in the fire-room and an auxiliary feed-pump in the engine-room. The main feed-pump will connect with the main feed pipe and will have a capacity sufficient to supply twice the amount of water necessary for the boilers when steaming at full power under forced draft. There will be one smoke-pipe.

The forced-draft system will consist of two blowers, which will discharge into the fire-room. Means will be provided for slicing the fires when under forced draft without opening the furnace doors. There will also be provision for regulating the supply of air to each furnace.

There will be a steam reversing gear, an ash-hoist, a turning engine, auxiliary pump, engine for driving work-shop machinery, a distilling apparatus, and such other auxiliary or supplementary machinery, tools, instruments, or apparatus as are described in the detailed specifications.

The Naval Academy practice-vessel.—The propelling engines will be rights and lefts, placed in a common water-tight compartment. These engines will be of the vertical, inverted-cylinder, direct-acting, triple-expansion type, each with a high-pressure cylinder 13½ inches, an intermediate-pressure cylinder 21 inches, and a low-pressure cylinder 31 inches in diameter, the stroke of all pistons being 20 inches. It is estimated that the collective indicated horse-power of propelling, air-pump, and circulating-pump engines should be about 1,300, when the main engines are making about 240 revolutions per minute. The high-pressure cylinder of each engine will be forward and the low-pressure cylinder aft. The main valves will be of the piston type for the high-pressure and in-intermediate-pressure cylinders, and slide-valves for the low-pressure cylinders, all worked by Stephenson link-motions with double-bar links. The piston-valves, valve-liners, and valve-gears will be made interchangeable. There will be one piston-valve for each high-pressure cylinder, two for each intermediate-pressure cylinder, and one slide-valve for each low-pressure cylinder. Each main piston will have one piston-rod, with a cross-head working on a bar-guide. The framing of the engines will consist of wrought-steel columns, trussed by wrought-steel stays. The engine bed-plates will be of cast-steel, supported on wrought-steel keelson plates built in the vessel. The crank-shafts will be made in three interchangeable sections. All shafting will be hollow. The shafts, piston-rods, connecting-rods, and working parts generally will be forged of mild open-hearth steel.

The condensers will be made entirely of composition. The main condenser will have a cooling surface of about 1,820 square feet, measured on the outside of the tubes, the water passing through the tubes. There will be a double, vertical, single-acting air-pump worked by a vertical compound engine. The circulating-pump will be of the centrifugal type, worked independently. The propellers will be right and left, of manganese bronze, or approved equivalent metal.

There will be an auxiliary condenser of sufficient capacity for the auxiliary machinery. The auxiliary condenser will have a combined air and circulating-pump.

There will be two straight-way fire tubular boilers, placed in a common water-tight compartment. The outside diameter of boilers will be about 8 feet 9½ inches, and the length about 17 feet over heads. They will be constructed for a working pressure of 160 pounds per square inch. Each of the boilers will have two corrugated furnace-flues 3 feet 3 inches internal diameter. The total heating surface will be about 2,640 square feet, measuring the tubes on the outer surface, and the grate surface, 78 square feet. There will be a main feed-pump in the fire-room and an auxiliary feed-pump in the engine-room. The main feed-pump will connect with a main feed-pipe, and will have a capacity sufficient to supply twice the amount of water necessary for the boilers when steaming at full power under forced draft. There will be one smoke-pipe.

The forced-draft system will consist of two blowers, which will discharge into main air-ducts under the fire-room floor, from which a branch duct will lead to the ash-pit of each furnace. Means will be provided for closing the ash-pits when under forced-draft and for preventing leakage of gases out of the furnace doors. The draft to each furnace will be regulated by means of a damper.

There will be steam reversing-gear, an ash-hoist, a turning-engine, auxiliary pump, an engine-room ventilating-fan, engine for driving work-shop machinery, a distilling apparatus, and such other auxiliary or supplementary machinery, tools, instruments, or apparatus as are described in the detailed specifications.

8,100 *ton armored cruiser.*—There will be four sets of propelling engines, two of which will be rights and two lefts, placed in two water-tight compartments and separated by a middle-line bulk-head. There will be two sets of engines on each shaft. The crank-shafts of the two sets of engines for each propeller must be so arranged that by means of an easily operated coupling the forward set may be quickly and easily connected with or disconnected from the after one at will. For ordinary cruising the after set attached to each shaft will be used. These engines will be of the vertical inverted-cylinder, direct-acting, triple-expansion type, each with a high-pressure cylinder 32 inches, an intermediate-pressure cylinder 46 inches, and a low-pressure cylinder 70 inches in diameter—the stroke of all pistons being 42 inches. It is estimated that the collective indicated horse-power of propelling, air-pump, and circulating-pump engines should be 16,000, when the main engines are making about 129 revolutions per minute. The high-pressure cylinder of each engine will be forward and the low-pressure cylinder aft. The main valves will be of the piston type, worked by Stephenson link-motions with double-bar links. There will be one piston-valve for each high-pressure cylinder, two for each intermediate-pressure cylinder, and two for each low-pressure cylinder. Each main piston will have one piston-rod, with a cross head working between guides. The framing of the engines will consist of cast-steel inverted Y-frames, two for each cylinder. The engine bed-plates will be of cast-steel, supported on wrought-steel keelson plates built in the vessel. The crank-shafts will be made in three sections. All shafting will be hollow. The shafts, piston-rods, connecting-rods, and working parts generally will be forged of mild, open-hearth steel.

The condensers will be made of composition and sheet-brass. There will be one condenser for each propelling engine. Each main condenser will have a cooling surface of about 5,559 square feet, measured on the outside of the tubes, the water passing through the tubes. For each propelling engine there will be two single-acting vertical air-pumps worked by a two-cylinder vertical inverted simple engine. The main circulating-pumps will be of the centrifugal type, one for each condenser, worked independently. The propellers will be right and left, of manganese bronze, or approved equivalent metal.

Each engine-room will have an auxiliary condenser, made of composition and sheet-brass, of sufficient capacity for one-half the auxiliary machinery, each condenser being connected with all the auxiliary machinery. Each of these condensers will have a combined air and circulating-pump.

There will be six double-ended main and two single ended auxiliary boilers, of the horizontal return fire-tube type, all to be made of steel.

The main boilers will be about 15 feet 3 inches outside diameter and about 21 feet 3 inches long. The auxiliary boilers will be about 10 feet mean diameter and 8 feet 6 inches long, all constructed for a working pressure of 160 pounds per square inch. The main boilers will be placed in two water-tight compartments, each compartment containing three double-ended boilers. There will be two athwartship fire-rooms in each of the main boiler compartments. Each of the double-ended boilers will have eight corrugated furnace flues, 3 feet 3 inches internal diameter. The total heating surface for the main boilers will be about 31,190 square feet, measured on the outer surface of the tubes, and the grate surface 988 square feet. The auxiliary boilers will be placed above the protective deck; each will have two corrugated furnace flues 2 feet 9 inches internal diameter. The total heating surface for the two auxiliary boilers will be about 1,937 square feet, measured on the outside of the tubes, and the grate surface about 64 square feet. There will be in each main fire-room in which the check-valves are placed two approved main and two approved auxiliary feed-pumps, and in each auxiliary fire-room an approved main and an approved auxiliary feed pump; also in each engine-room an auxiliary feed-pump, a fire and bilge-pump, and a water service-pump. There will be two smoke-pipes.

The forced-draft system will consist of three blowers for each fire-room for the main boilers, and one in each fire-room for the auxiliary boilers, the blowers for the main boilers discharging into an air-tight fire-room. Air-tight bulkheads will be fitted so as to reduce the space to be maintained under pressure.

There will be steam reversing-gear, ash-hoists, turning engines, auxiliary pumps, engine-room ventilating-fans, engine for work-shop machinery, hydraulic pumping plant for various purposes, gun-table or turret turning engines, a distilling apparatus, and such other auxiliary or supplementary machinery, tools, instruments, or apparatus as are described in the detailed specifications.

3,130-*ton armored cruising monitor.*—The propelling engines will be rights and lefts, placed in water-tight compartments and separated by a middle-line bulkhead. These engines will be of the vertical inverted-cylinder, direct-acting, triple-expansion type, each with a high-pressure cylinder 31¼ inches, an intermediate-pressure cylinder 46 inches, and a low-pressure cylinder 70 inches in diameter, the stroke of all pistons being 36 inches. The collective indicated horse-power of propelling, air-pump, and circulating-pump engines will be 7,500 when the main engines are making about 150 revolutions per minute. The high-pressure cylinder of each engine will be forward and the low-pressure cylinder aft. The main valves will be of the piston type, worked by Stephenson link-motions with double-bar links. The piston valves and valve-liners of the high-pressure and intermediate-pressure cylinders of both engines will be made interchangeable. The valve-gears of the high-pressure and intermediate-pressure cylinders will be interchangeable.

There will be one piston-valve for each high-pressure cylinder, two for each intermediate-pressure cylinder, and three for each low-pressure cylinder. Each main piston will have one piston-rod, with a cross-head working between guides. The framing of the engines will consist of cast-steel inverted Y-frames. The engine bed-plates will be of cast-steel, supported on wrought-steel keelson plates built in the vessel. The crank-shafts will be made in three interchangeable and reversible sections. All shafting will be hollow. The shafts, piston rods, connecting-rods, and working parts generally will be forged of mild open-hearth steel.

The condensers will be made of composition and sheet-brass. Each condenser will have a cooling surface of about 5,237 square feet, measured on the outside of the tubes, the water passing through the tubes. For each propelling engine there will be a double vertical, single-acting air-pump worked by a vertical compound engine. The circulating-pumps will be of the centrifugal type, one for each condenser, worked independently. The propellers will be right and left, of manganese bronze, or approved equivalent metal.

Each engine-room will have an auxiliary condenser of sufficient capacity for one-half the auxiliary machinery, each condenser being connected with all the auxiliary machinery. Each of these condensers will have a combined air and circulating-pump.

There will be eight single-ended steel boilers of the horizontal return fire-tube type, about 12 feet 6 inches outside diameter and about 10 feet 11 inches long, all constructed for a working pressure of 160 pounds per square inch. They will be placed in two equal groups in two water-tight compartments. The fire-room in each of the boiler compartments will be fore and aft. Each of the boilers will have three corrugated furnace flues 3 feet internal diameter. The total heating surface will be about 15,050 square feet, measured on the outer surface of the tubes, and the grate surface 444 square feet. There will be in each boiler compartment an approved main feed-pump and in each engine-room an auxiliary feed-pump. There will be one smoke-pipe.

The forced-draft system in each compartment will consist of two blowers, which will discharge into main air-ducts under the fire-room floor, from which a branch duct will lead to the ash-pit of each furnace. Means will be provided for closing the ash-pits when under forced draft, for admitting a part of the air to the top of the fire, and for preventing leakage of gases out of the furnace doors. The draft to each furnace will be regulated by means of a damper.

There will be steam reversing-gear, ash-hoists, turning engines, auxiliary pumps, engine-room ventilating-fans, engine for work-shop machinery, hydraulic pumping plant for various purposes, turret-turning engines, a distilling apparatus, and such other auxiliary or supplementary machinery, tools, instruments, or apparatus as are described in the detailed specifications.

BOILERS.

THE LAGRAFEL AND D'ALLEST BOILER.

The boiler consists of two plain flat-sided water-chambers, forming the front and back of the boiler, securely braced by numerous stay-bolts, and the two connected by tubes. Above the tubes they are again connected by a cylindrical drum, in the lower part of which is the normal water-level, and the upper part of which is the steam-space. The whole is placed over the grates in an inclined position, the front being higher than the rear. The tubes are expanded against the tube sheets but are not beaded over. Opposite each end of each tube there is a hole in the outer shell, sufficiently large to admit of the withdrawal and replacement of the tubes, closed by the ordinary plate and crow's-foot when the boiler is ready for use. At one side of the furnace the tubes are omitted, forming the combustion-chamber. Over the lower row of tubes is placed a floor of fire-brick forming the crown of the furnace, and over the upper row a similar floor dividing the tube-box from the space underneath the drum. The hot gases thus pass to one side of the furnace, up among the tubes, in a direction parallel to the front of the boiler, then up underneath the drum, in a reverse direction, to the smoke-pipe. At the exit side of the tube-box, a hanging baffle-plate prevents the escape of the gases at the top, and forces them to pass amongst the lower tubes.

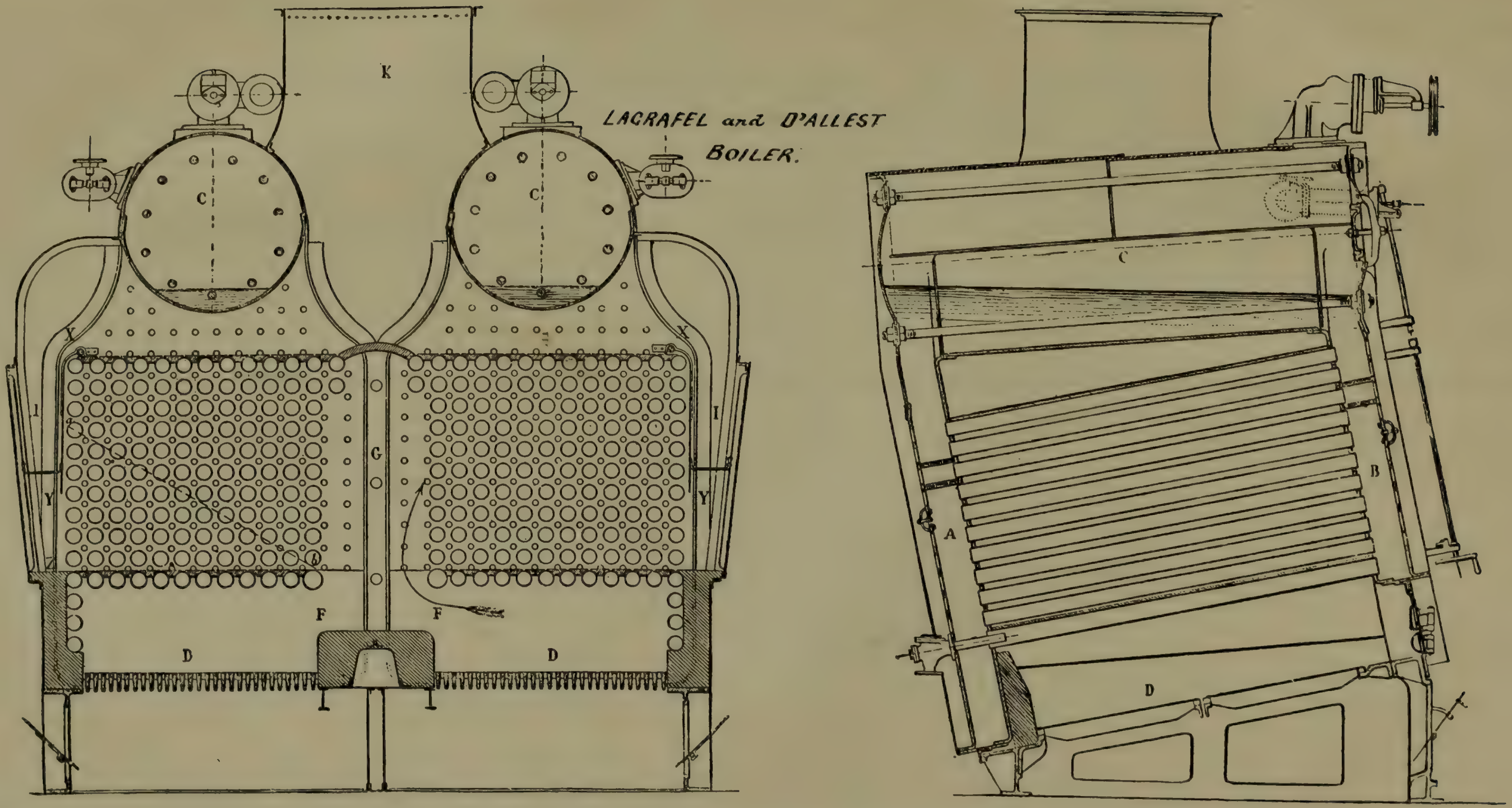
In a double boiler, as shown in the sketch, the combustion-chamber is common to both.

A six-hour trial with this boiler gave the following results:

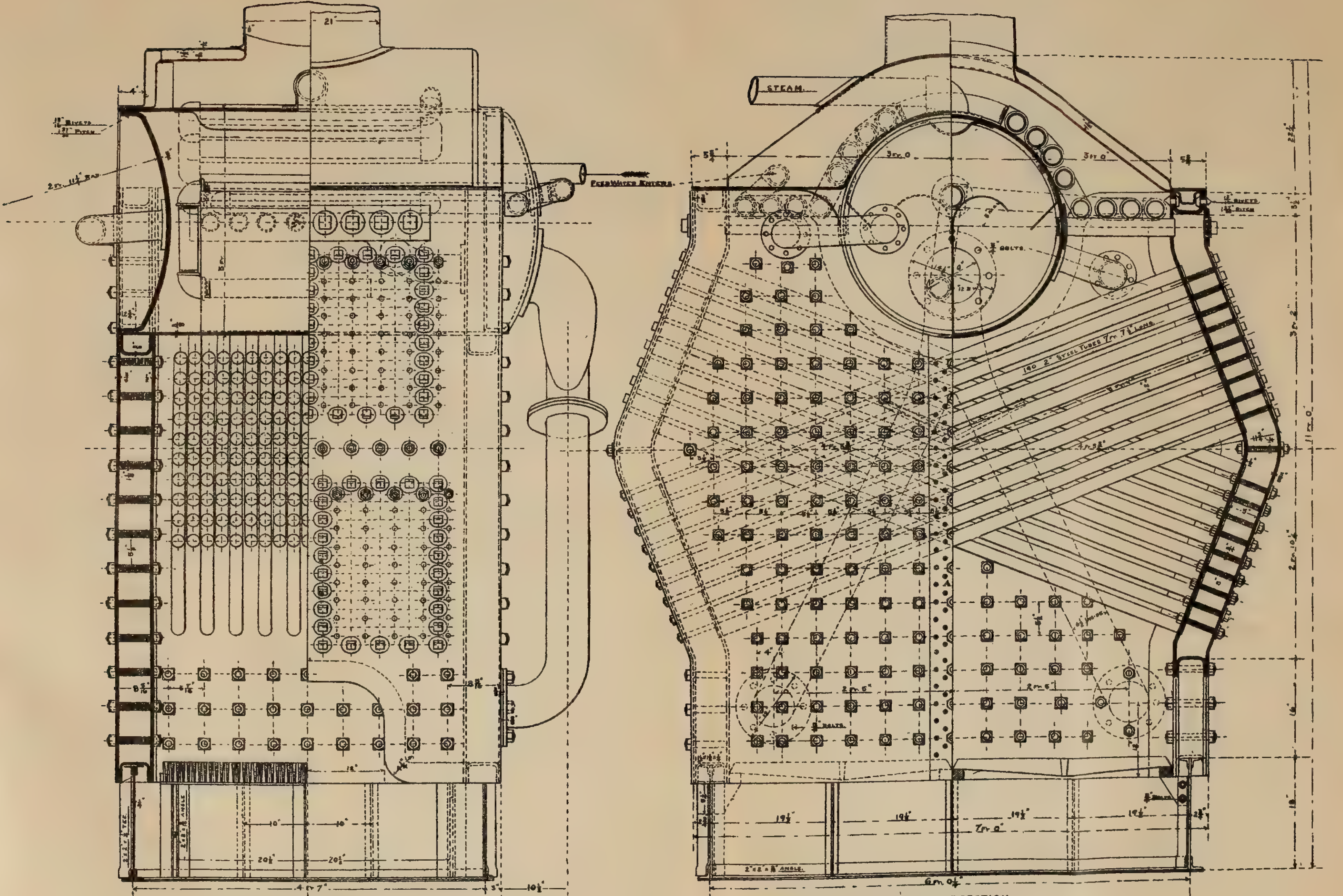
Draft.	Pounds coal per square foot of grate per hour.	Pounds water evaporated per pound of coal.
Natural	10.24	10.67
	15.16	9.58
	15.36	9.23
	15.57	9.04
	20.48	9.45
Forced	30.72	8.82
	40.96	8.89
	51.20	8.43

THE TOWNE BOILER.

The boiler is of the box form, and consists of an inner and outer shell securely braced by screw stay-bolts, and forming between them the steam and water spaces. The sides of the boiler are inclined at an angle of about 30 degrees with the vertical, making the lower half of one side parallel with the upper half of the other side. These parallel sides of the inner shell form the tube-sheets and are connected by straight tubes



LAGRAFEL and D'ALLEST BOILER.

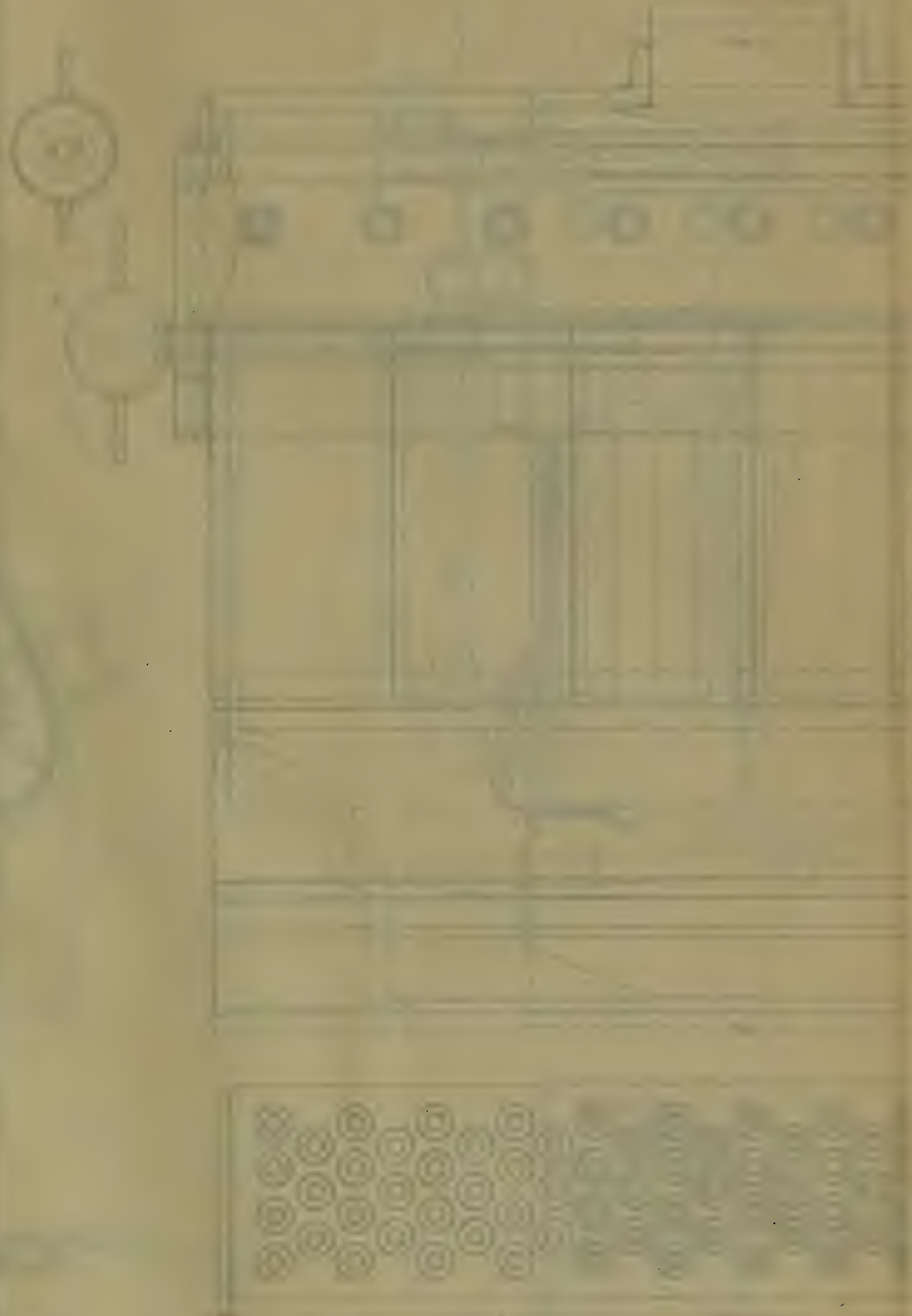


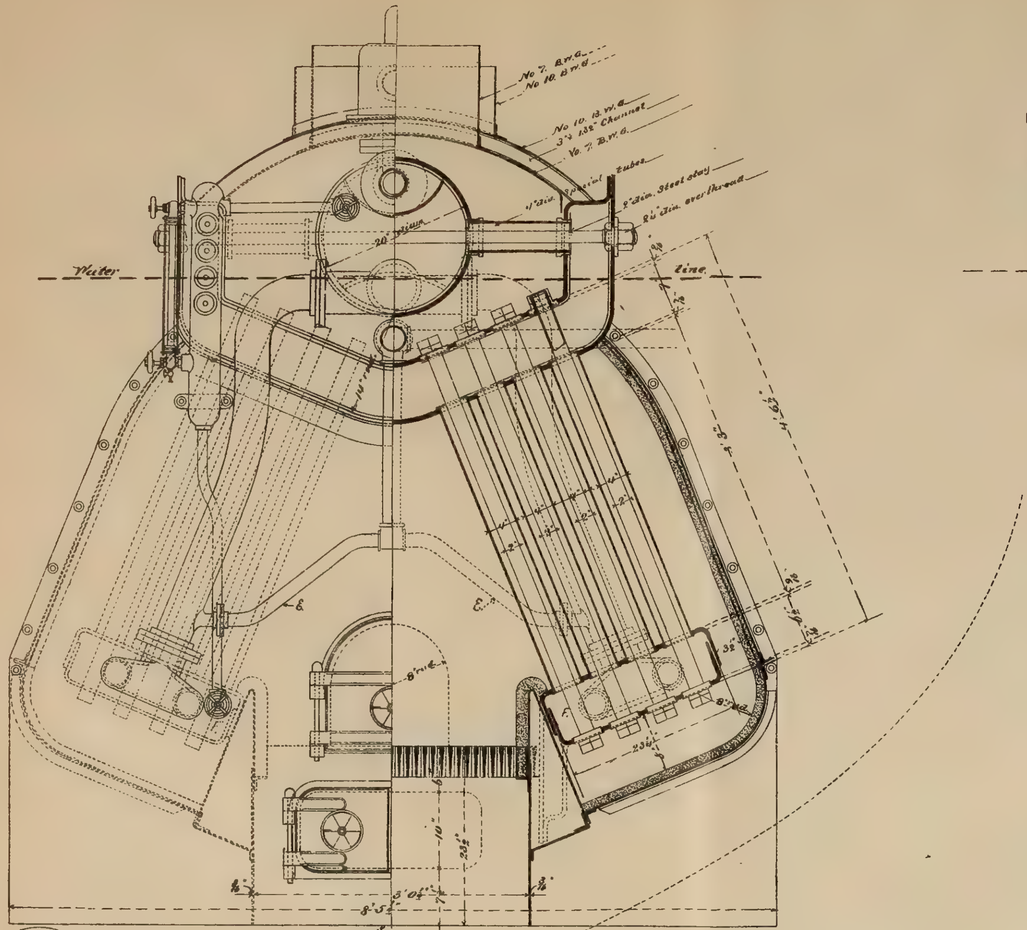
FRONT ELEVATION AND HALF SECTION.

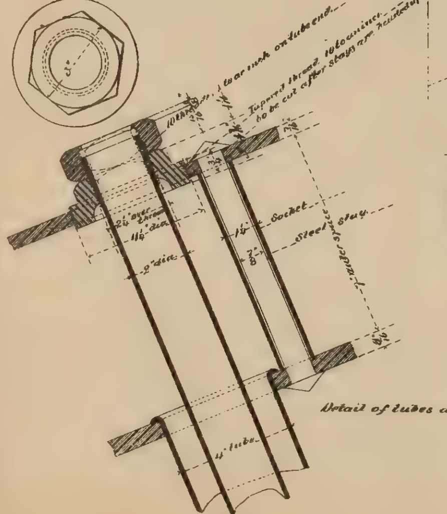
SIDE ELEVATION AND HALF SECTION.

TOWNE BOILER

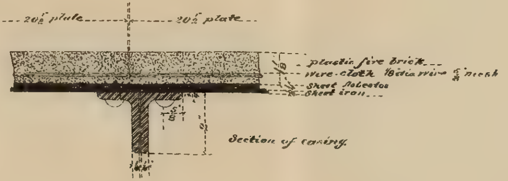
GRATE SURFACE	24 SQ. FT
HEATING "	956 " "
RATIO OF GRATE TO HEATING SURF.	1 : 39.83



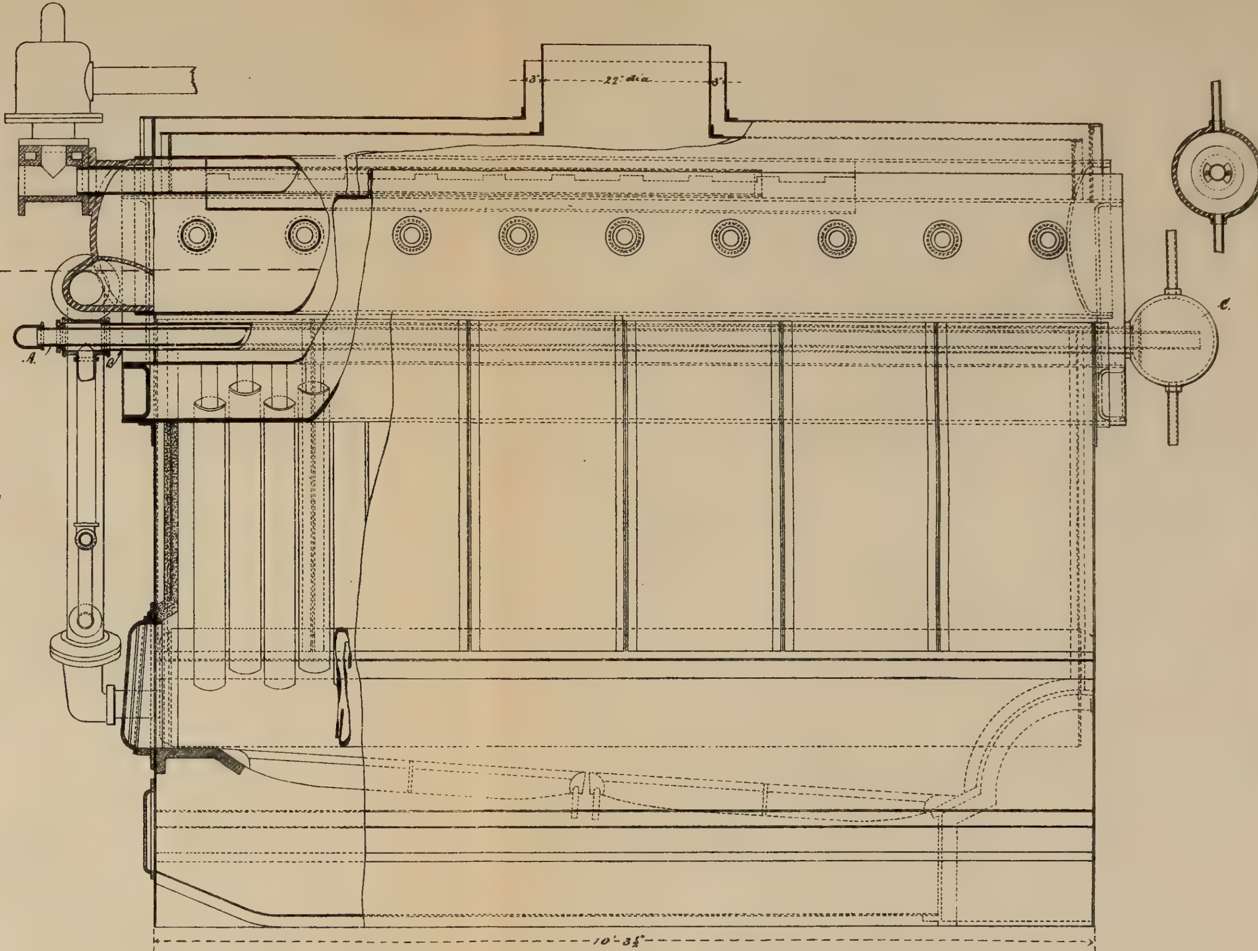


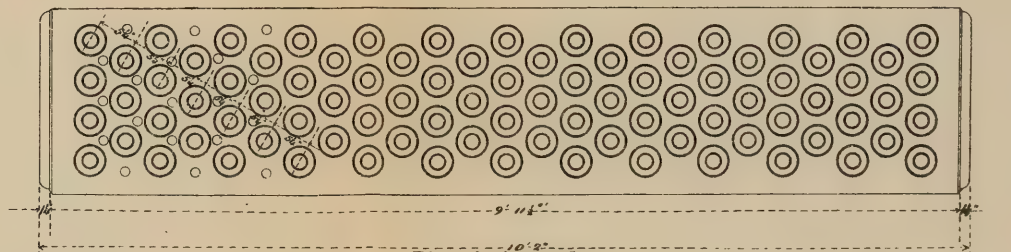

Tapered thread 10 to an inch to be cut after stays are headed
4 to an inch on tube ends
Socket
Steel stay
2" dia.
4" tube

Detail of tubes and Socket stays



Section of casing





Plan of wing chamber.

Bartlett Steam Generator.

Jno E T Bartlett. Patentee.

Patent No 426614 April 29th 1890

Scale 1½ = 1'

Washington D.C.

May 28 1890

arranged in groups, the angle of inclination being reversed for each group. Over the tubes in the spandrel formed by the alternately inclined groups is a cylindrical drum connected to the boiler proper at its highest part by short horizontal tubes. The grate is placed directly below the tubes at a distance sufficiently great to form the furnace, and with the spaces between the tubes the combustion-chamber. The uptake which surrounds the steam-drum is surmounted by the smoke-pipe. At the rear of the drum, and outside of the shell, is a downcast pipe, entering the water-space at its lowest part. The feed-water enters the lower part of the drum, after having traversed a coil of pipe in the uptake which acts as a feed-water heater. The interior of the drum is fitted with numerous baffle-plates and a dry-pipe. In the outer shell, opposite both ends of each tube, are holes large enough to permit of the removal of a defective tube, and the replacing and expanding of a new one. The holes are closed by screw plugs.

THE BARTLETT BOILER.

The boiler consists of an upper chamber, U-shaped in section, from which are suspended by 4-inch water-tubes, two other chambers, one each side of the grate. Through these water-tubes pass 2-inch fire-tubes, connecting the spaces below the side chambers with the space above the upper chamber. In this upper space is also placed the steam-drum, connected on both sides with the upper ends of the U-shaped chamber, by short horizontal 4-inch tubes, through which and the drum pass the 2-inch tie-rods holding together the legs of the U. As is customary with all boilers of this general type, there is a down-cast pipe connecting the lower part of the drum to the side chambers. Just beneath the steam-drum, extending the entire length of the boiler from front to rear, is the feed-pipe, formed of two concentric pipes terminating in a spherical chamber outside the boiler shell. The feed-water enters through the inner pipe, and is heated to the temperature due to the pressure carried, during its passage to the spherical chamber, where separation of the solid matter and extraction of the grease takes place. It then returns through the annular space between the two pipes, to the front of the boiler, where it passes down an outside pipe, and enters the downcast pipes just above their junction with the side chambers. The bottom of the upper chamber forms the crown of the furnace. The products of combustion pass amongst the tubes to the outer shell, thence down to the spaces below the side chambers, thence up through the fire-tubes to the uptake, in which the steam-drum is situated and around which the hot gases pass, on their way to the smoke-pipe. The steam-drum is fitted with baffle-plates and a dry-pipe, and all flat surfaces are securely braced with socket or screw stay-bolts.

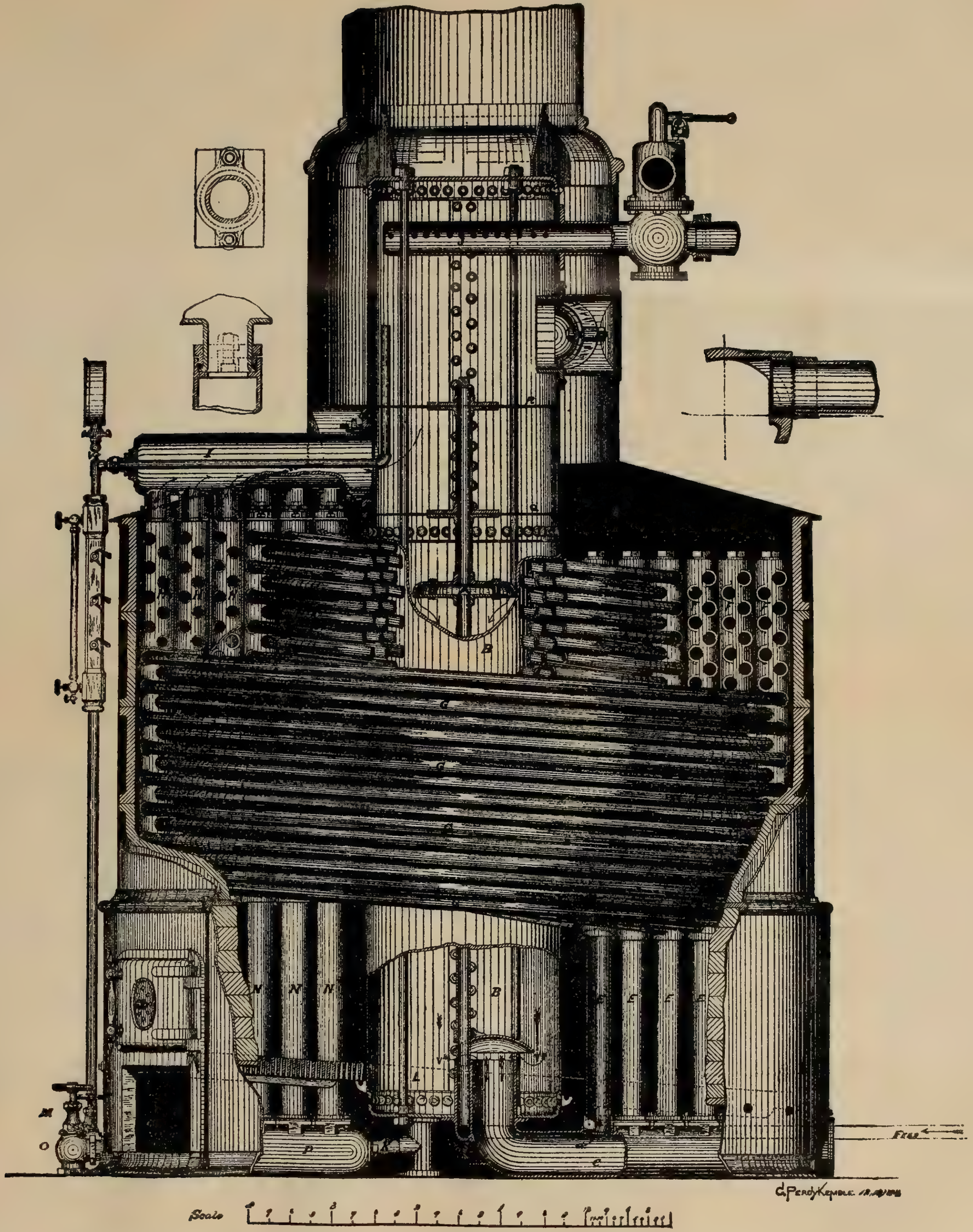
THE WARD BOILER.

This boiler consists of a vertical, central, cylindrical drum, from which, in a plane passing through the axis, extend three manifolds, C, P, and I. From the manifold C rise several (in the sketch six) vertical pipes, their upper ends fitted to receive tubes, as shown, and their tops closed. Similar pipes are fitted to the manifold P, but their upper ends, instead of being closed, are in communication with the manifold I. These vertical pipes are connected by numerous tubes, curved to a semi-circular arc, and placed at a slight angle with the horizontal. The manifold C extends up into the drum a short distance, and has a baffle-plate across the top, while the manifold P has a contracted connection with the bottom of the drum. The feed-pipe enters the bottom of the drum and passes up the centre, to about the level of the water in the pipes, where it ends with a scattering-plate. The grate extends underneath all the tubes, and the shell is fitted with two doors, one for each side of the dividing wall formed by the vertical pipes. A dry-pipe is fitted in the steam-space at the top of the boiler.

The feed-water enters by the feed-pipe, and is discharged over the scattering-plate into the drum. From the bottom of the drum it passes into the manifolds C and P (principally into C), rises in the pipes E, passes through the tubes G to the pipes H, thence through the manifold I to the drum. Any water carried to this point falls back to the bottom of the drum, while the steam rises to the steam-space. The principal supply of steam and water for the pipes H and manifold I comes from the tubes G, while a slower circulation is taking place in the pipes N, which are fed through the manifold P and pipe K. Any foreign matter in the water will therefore gravitate toward the manifold P, from whence it can be blown out through the valve O.

The following table shows a comparison of the performances of some of these boilers with others, descriptions of which will be found in General Information Series, Nos. VII and VIII. The table is taken from an article entitled Tubulous Boilers, by Assistant Engineer S. H. Leonard, U. S. N., Journal of the American Society of Naval Engineers, May, 1890.

Although these tests are not strictly comparable, on account of the great disparity in size of boiler, ratio of heating to grate surface, and variety of working, they can be taken to fairly represent the comparison intended by the writer, viz: The relative weight and space occupied by the three types of boiler—tubulous, locomotive, and Scotch.



WARD'S STEAM GENERATOR.

TOTAL { HEATING SURFACE 1381 } SQUARE FEET
GRATE " 42

[illegible]

Boilers.

Type.	Dimensions.	Grate area.	Heating surface.	Ratio.	Combustion per square foot grate.	Evaporation from and at 212° Fahr.				Per cent. moisture.	Weights.					Air pressure, inches of water.	Steam pressure.	Coal.
						Per pound coal.	Per pound combustible.	Per square foot H. surface.	Per cubic foot space.		Empty.	Steaming level.	Per I. H. P.	Per square foot H. surface.	Per pound water evaporated.			
											Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		*Lbs.*	
Belleville	Length, 8′ 6″																	
	Width, 7′ 0″	34.17	804	1 to 23.5	12.8	9.6	10.42	5.2	6.4	6.31	40,670	42,770	204	53.2	10.1	(*)	111	Bituminous.
	Height, 11′ 0″																	
	Space, 654.5 cu. ft.																	
Herreshoff	Length, 4′ 9″				9.3	7.6	10.23	3.1	9.1	3.5			96		4.8	(†)	120	Anthracite.
	Width, 3′ 8″	9	205.3	1 to 22							2,945	3,050		14.8				
	Height, 4′ 0″				25.8	7.14	8.68	8	23.8				36		1.8	(†)	195	Do.
	Space, 69.6 cu. ft.																	
Towne	Length, 2′ 6″				4.3	10.46	13.4	2.7	10				172		8.1	(*)	148	Do.
	Width, 2′ 6″	4.25	75	1 to 17.6							1,380	1,640		21.8				
	Height, 3′ 3″				24.5	5.6	6.77	8.2	30.4				56		2.6	1.14	152	Do.
	Space, 20.3 cu. ft.																	
Ward	Diameter, 3′ 2″				7.9	8.59	10.77	1.7	5.8				154		7.7	(*)		Do.
	Diameter, drum, 1′ 7″	3.68	145.8	1 to 39.5	15.5	8.28	10.01	3.2	11		1,682	1,930	82	13.2	4.07	(†)	17	Do.
	Height, 7′ 2″				62.5	6.34	7.01	10	34.2				26		1.3	(†)	161	Bituminous.
	Space, 42.7 cu. ft.																	
Scotch	Diameter, 9′ 0″				24.8	8.13	9.93	8.6	11	3.44			120		4.7	2.08	77	Anthracite.
	Length, 9′ 0″	31.16	727.2	1 to 23.3							18,900	30,000		41.2				
	Space, 572.5 cu. ft.				38	7.87	9.06	12.8	16.3	4.29			80		3.1	4.01	78	Do.

* Natural.

† Jet.

Boilers—Continued.

Type.	Dimensions.	Grate area.	Heating surface.	Ratio.	Combustion per square foot grate.	Evaporation from and at 212° Fahr.				Per cent. moisture.	Weights.					Air pressure, inches of water.	Steam pressure.	Coal.
						Per pound coal.	Per pound combustible.	Per square foot H. surface.	Per cubic foot space.		Empty.	Steaming level.	Per I. H. P.	Per square foot H. Surface.	Per pound water evaporated.			
											Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		*Lbs.*	
Locomotive torpedo.	Length, 16′ 8″				98.3	6.97		17.1	30.5				47.7		1.8	3.13	125	Bituminous.
	Width, 6′ 4″	28	1,116	1 to 39.8								34,990		31.3				
	Height, 7′ 6″				120.8	6.62		20.05	36.2				33.3		1.2	4.95	123	Do.
	Space, 630.3 cu. ft.																	
Ward	Diameter, 10′ 3″																	
	Diameter, drum, 4′ 6″	53	2,473.5	1 to 46.6	55.04	8.03	8.44	9.47	32.1	11.6	26,538	30,474	26	12.3	1.3	2	160	Do.
	Height, 11′ 8″	66.5	2,490	1 to 37.4														
	Space, 729.3 cu. ft.																	
Thornycroft. (U.S.S. Cushing.)	Length, 10′ 0″*																	
	Width, 7′ 0″*	38.3	2,375	1 to 62	45						20,160	24,640	*31	10.3		3	245	Do.
	Height, 8′ 0″*																	
	Space, 560 cu. ft.*																	

* Approximate.

In the case of the large Ward boiler, the grate area and heating surface *used* are given, the actual areas are added below. The evaporation, apparent in each case, is from and at 212 degrees. Where calorimetric tests were made the percentage of moisture is given.

The weight per I. H. P. is estimated on a basis of 20 pounds of water per hour for all cases excepting the Scotch boiler, where 25 pounds has been used, as this boiler was limited to 80 pounds pressure of steam.

The following approximation is made from the table on the assumption that the evaporation varies directly as the combustion, and 25 pounds of coal per square foot of grate per hour used as the unit. This assumption is manifestly unfair to those boilers using a high rate of combustion; however, leaving the *small* Ward boiler out of the comparison, it will be seen that the locomotive boiler is the only one to suffer. The *large* Ward boiler, although burning 55 pounds of coal per square foot of grate, has approximately the same evaporation per pound of coal as the others at 25 pounds. These figures, speaking for themselves, need but little comment. The locomotive boiler should receive a favorable correction of about 20 per cent. in columns 2, 3, and 5, on account of the high rate of combustion. On the other hand, the Belleville boiler should receive an adverse correction of about 10 per cent., on account of low combustion; but even without this correction it is seen that this boiler has no practical advantage over the Scotch, either in space occupied or weight. All the other tubulous boilers given greatly *exceed* the Scotch in these advantages of weight and space.

Type.	1.	2.	3.	4.	5.
	Combustion.	Evaporation per cubic foot of space.	Weight per I. H. P.	Weight per square foot of heating surface.	Weight per pound of water evaporated.
Belleville	.5	.5	2.02	2.1	2.5
Herreshoff	1.	.95	.72	.6	.9
Towne	1.	1.2	1.12	.87	1.3
Scotch	1.	.44	2.4	1.64	2.3
Locomotive	3.9	.31	3.7	1.25	3.5
Ward	2.2	.58	1.27	.5	1.53

Induced draft.—The British admiralty authorities have been carrying out some experiments under the superintendence of Mr. W. A. Martin on induced draft. The trials were made at the Portsmouth dockyard, upon a locomotive boiler which had been condemned and removed from H. M. S. *Polyphemus*. In this boiler the fire-box is divided by a water partition up to 9 inches from the tube-plate, which carries 156 tubes 1½ inches inside diameter, and 8 feet 6 inches long. The two furnaces are 23 inches wide and 5 feet 6 inches long.

Forced draft has been found to be extremely detrimental to tubes and tube-sheets, and it has been almost the exception for a war-ship to complete even her forced-draft trials without serious injury to the boilers. Forced draft also requires skilled firing in order to get the maximum beneficial results from the practice, which in itself is a disadvantage of no small moment.

The fact that in ordinary locomotive practice heavy fires have been and are daily used with a draft no less powerful than the forced draft of marine practice, and with no trouble whatever from tubes and tube-sheets, has caused the attention of engineers to be directed to the matter, with the result that *induced draft* is to supplant *forced draft*, if the results of the experiments now being made prove conclusively that all the ills of artificial draft, as heretofore used in the marine service, may be done away with by making this change.

The following table gives the results of three trials made at the Portsmouth dock-yard. Other trials are to be made upon the completion of the retubing of the boiler, now being done:

Induced draft (rates per hour).

	Date of trial (1890).		
	Mar. 20.	Apr. 2.	Apr. 10.
Coal consumed .... pounds..	840	771	802
Coal consumed per square foot of grate .... do....	51.5	39	40.5
Water evaporated .... do....	8,419.2	7,075	7,902.5
Water evaporated per square foot of grate at actual temperature .... pounds..	516	357	399
Water evaporated per square foot of grate at 212 degrees ... do....	604	416.9	465
Water evaporated per pound of coal at actual temperature.. do....	10	9.17	9.84
Water evaporated per pound of coal at 212 degrees .... do....	11.75	10.7	11.49
Water evaporated per square foot of heating surface at actual temperature .... pounds..	9.16	7.7	8.9
Water evaporated per square foot of heating surface at 212 degrees .... pounds..	10.73	9.0	10.38
Average temperature of feed .... degrees..	46	50	50
Average pressure of steam .... pounds..	70	70	70
Areas of fire grates .... square feet..	16.32	19.8	19.8
Horse-power	420	354	395

In connection with the Thornycroft water-tube boiler it is interesting to note that glass gauge tubes have been found unsuitable for the high pressure (250 pounds per square inch), which has been adopted with some of the most recent of these boilers. Up to 200 pounds per square inch no difficulty is found in using glass, but the addition of another 50 pounds seems to overtax this material. The difficulty has been got over by using talc, as Mr. Perkins had previously done with his high-pressure steam-generator. (Engineering.)

Risk in connection with evaporators.—In connection with the use of evaporators, for making up feed with fresh instead of salt water for boilers, there is a risk which we believe is not provided for in existing apparatus. When the evaporator delivers the steam formed in it into one of the receivers, then as soon as the heating-surfaces of the

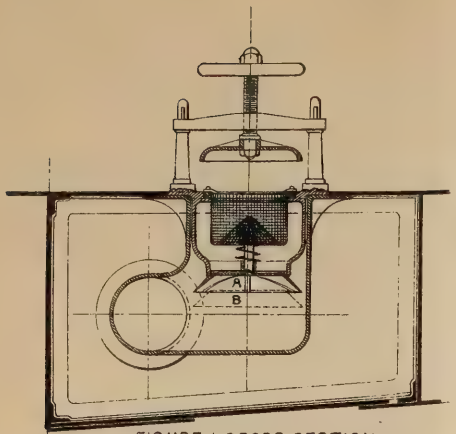


FIGURE I CROSS SECTION THROUGH DRAIN PIPE AND VALVE CASING.

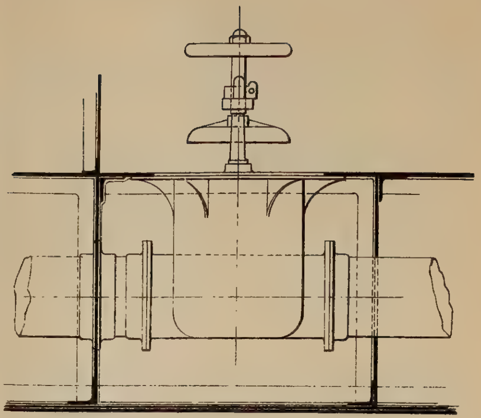


FIGURE 2 FORE AND AFT ELEVATION OF DRAIN PIPE AND VALVE CASING.

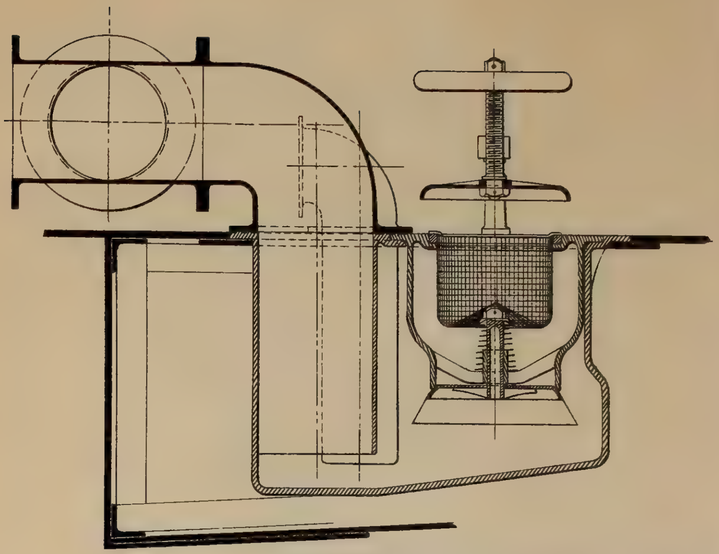


FIGURE 6 CROSS SECTION THROUGH CISTERN AND VALVE CASING SHOWING MAIN AND AUXILIARY DRAIN PIPES.

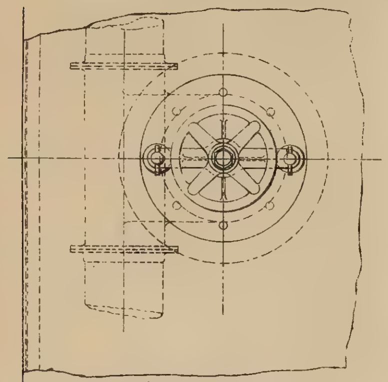


FIGURE 3 PLAN OF DRAIN PIPE AND VALVE.

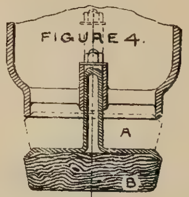


FIGURE 4.

DETAILS OF FLOAT VALVE THAT MAY BE USED INSTEAD OF VALVE SHOWN IN FIGURE 5.

NON-RETURN DRAIN VALVE

DESIGNED BY

HAROLD P. NORTON
ENGINEER CORPS U. S. N.
PATENTED NOVEMBER 5TH. 1889.

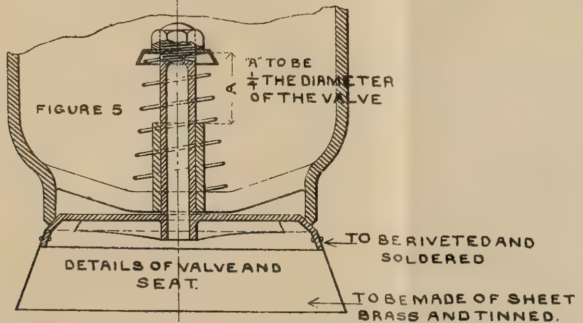

"A" TO BE $\frac{1}{4}$ THE DIAMETER OF THE VALVE
A
TO BE RIVETED AND SOLDERED
DETAILS OF VALVE AND SEAT.
TO BE MADE OF SHEET BRASS AND TINNED.

FIGURE 5

FIGURES 1, 2, AND 3 SHOW THE DRAIN PIPES PLACED BETWEEN THE INNER AND OUTER SKINS.
FIGURE 6 SHOWS THE DRAIN PIPE ABOVE THE INNER SKIN.

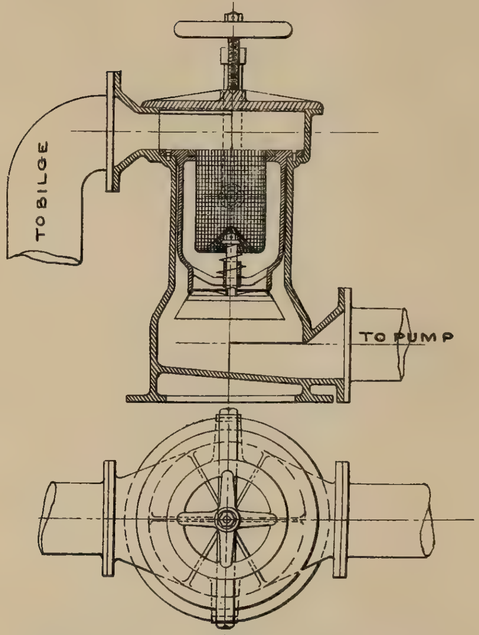


FIGURE 7 CROSS SECTION AND PLAN OF VALVE FOR BILGE PUMP SUCTION PIPE.

evaporator become coated with scale, and the conductivity is thereby impaired, the surfaces do not perform the necessary evaporation, and under these conditions the evaporator gradually fills with sea-water. This latter, on overflowing, goes up into the receiver, and is likely to cause any of the usual complications due to the presence of water in the cylinders. Again, supposing that the evaporator is so connected that the vapor goes to the condenser, under like circumstances—that is, the heating efficiency being impaired—after the evaporator is full of salt-water it will overflow into the steam-space of the main condenser, and if no other result accrues the boilers will receive much salt—the very purpose the evaporator is put in to avoid. If the means of regulating the feed to the evaporator and maintaining the water level therein is not reliable, and so designed that any inflow of water to the supply requisite for evaporation will be automatically ejected, the same results may arise from want of attention on the part of the attendant whose duty it is to regulate the supply of water to the apparatus. It is worth the while of manufacturers, and also of the board of trade, whose efforts at the present time are being rigorously directed to making the evaporator a machine safe to be placed in the engine-room, not to overlook this very simple though important detail. (Engineering.)

The *Texas* is to be fitted with the non-return valve shown on the opposite page. This valve was designed in 1887 by Assistant Engineer Harold P. Norton, U. S. N., to overcome the defects in the valves fitted on board the U. S. S. *Atlanta*. The objects sought were: A valve that could bere moved for repairs from above the inner skin; that was positive in its action; that had no portion of its casing projecting above the inner skin, preventing the complete drainage of the floor; that could be fitted with a basket strainer; and that could be cleaned and examined by simply removing the strainer.

In Fig. 1, A shows the normal position of the valve, the tension of the spring being regulated by the nut so that it is just sufficient to overcome the weight of the valve. As soon as any water collects on the upper surface of the valve its weight overcomes the tension of the spring and the valve opens to the position shown at B, and the water escapes into the drain-pipe. As soon as the water escapes the valve returns to its original position at A.

As shown in Fig. 5, the lower side of the valve is made so as to form an air-chamber, and if by any accident or neglect the spring should be broken and the valve allowed to fall open, the air-chamber will close the valve when the water rises in the drain-pipe and valve-casing.

The valve can be used with the drain-pipes between the two skins, as shown in Figs. 1, 2, and 3, or when the drain-pipes are above the inner skin, as shown in Fig. 6.

Fig. 7 shows a design for a bilge-pump suction-pipe to prevent water running into the bilge if the pump-valves should leak or the suction-pipe be connected to a manifold fitted with a sea connection. The valve and spring can be examined and cleaned by removing the basket strainer, and the valve and seat removed and a new one fitted by removing the valve-casing. Fig. 4 shows a float-valve that can be used in the same casing, if it is preferred, but it is not so satisfactory, as its normal position is open instead of closed.

The advantages of a basket strainer on bilge-pipes are too well known to all who have been at sea with a box or perforated plate strainer to make it necessary to enumerate them. When a strainer made of perforated plate, either flat or in box form, becomes choked and is flooded, it is an impossibility to clear it, and some other means must be used to get the water to the pumps.

C. W. Rae,
Passed Assistant Engineer, U. S. N.

III.

NOTES ON ORDNANCE AND ARMOR.

ORDNANCE.

The record of progress in ordnance during the past year contains references to the following items of interest:

The appearance in actual service of the high-power and rapid-fire guns of the *Canet* type and the results obtained from them on proof-trials:

The trial and practical failure of the *Victoria's* 110-ton guns:

The construction of new types of rapid-fire guns, and some pressure and velocity tests from armor-piercing guns of this system:

The adoption of several new designs of magazine small-arms:

The unusual degree of activity in the search after a practical high explosive for armor-piercing shells and a reliable smokeless powder:

The introduction of improved means of handling ammunition for, and loading turret and barbette guns.

High angle fire is receiving renewed attention in foreign countries, particularly in England, Belgium, Russia, and Italy, the pieces employed being generally rifled howitzers of large calibre, mounted on hydro-pneumatic recoil-carriages which are so arranged as to permit of loading with the gun at level.

The Elswick firm has experimented with a ship's mount and platform for this kind of fire from high-power breech-loading rifles.

The opinion, heretofore so frequently expressed by ordnance experts, that the proper limit for weight and calibre of high-power guns has been exceeded in the monster guns now afloat in foreign navies, has now become almost general with naval authorities. This spread of opinion has been occasioned by a study of the actual working of these guns under trial at sea, during which the following disadvantages for naval use have become apparent:

(1) Excessive weight, necessitating for their handling the use of delicate and complicated hydraulic or other machinery which is liable to get out of order at any time, particularly when subjected to the rough shocks and sudden strains incident to use at sea. The value of a gun depends principally upon its trustworthiness, and in this case, with such enormous weights, the gun is entirely dependent upon its machinery, which, once out of order, renders the weapon practically worse than useless.

(2) Great length, which is a serious inconvenience on board ship, and an added source of danger from the larger rapid-fire projectiles :

(3) The considerably increased weight of armor necessary to give adequate protection to the gun and its machinery:

(4) The slow rate of fire due to the heavy weights of charge and projectile and to the complexity and unwieldiness of the loading and pointing arrangements. In the 67-ton and 110-ton English guns it is said that a force of about 10 tons has to be exerted by the hydraulic mechanism in order to withdraw the breech screws.

In addition, it may be said that these guns have a degree of power much in excess of what is necessary, an advantage which, from the nature of the service conditions under which guns are used, does not outweigh the disadvantages mentioned above.

It is now generally believed that, for naval purposes, a gun of 12-inch calibre and of not more than 50 tons total weight, will be sufficiently large to meet all requirements, and not being entirely dependent on delicate mechanism, can, in case of an accident to its machinery, be worked by hand.

At the distance of a mile, beyond which it is not probable that naval actions will take place, such a gun would have power sufficient to penetrate the side of nearly every armored vessel afloat. When we consider that during the year just past, gunnery has made such enormous strides that a muzzle velocity of 2,562 f. s., with a safe chamber pressure, has been obtained from a 9.45-inch high-power gun, we can feel safe in assuming that no larger gun than a modern 12-inch is now needed on board ship.

That such a standard would suffice for the heaviest naval armament is evident from an inspection of the following tabulated details of similar guns now either in service or in course of construction:

Nation.	Gun.	Weight.	Length in calibres.	Charge.	Projectile.	Muzzle velocity.	Muzzle energy.	Energy per ton of gun.	Energy per pound of powder.	Penetration in steel.		
										Muzzle.	1,000 yards.	2,000 yards.
		Tons.		*Lbs.*	*Lbs.*	*f. s.*	*f. t.*			*In.*	*In.*	*In.*
England	12-inch B. L. R..	45	25.2	295	714	1,892	17,720	394	60	18.4	16.6	14.7
Russia..........	....do	50.5	30	247	732	1,942	19,140	379	77	19.4	17.6	15.7
U. S. (Navy)....	....do	46	35	425	850	2,000	23,569	515	56	22.5	20.7	18.8

With a reliable smokeless powder the power of these guns will be greatly increased.

The combined weight of two of the United States Navy 12-inch guns is nearly 20 tons less than that of one English 110-ton gun; and when to this is added the difference in weights of mounts, ammunition, and other accessories, it will be seen that *three* of the smaller guns will put but little more weight on board ship than will one of the larger, not to speak of the possibility of constructing them with more ease and quickness and of superior endurance, and of obtaining from them a greater rapidity of fire, with the additional decided advantage of being able to man handle them in the event of an accident to their machinery.

The effect of blast has been partially shown in the ship trials of H. M. S. *Trafalgar's* 67-ton guns. On some foreign armored vessels the damage from this cause has been so great as to necessitate orders against firing the echelon turret guns except on their own side of the vessel, and then not more than 30 degrees forward or abaft the beam.

From the few trials made to ascertain the effect of blast on protective decks we judge that no high-power gun from 6-inch up should have the axis of its bore at a less distance above the plane of the deck than a number of feet equal to three-fourths the calibre of the gun expressed in inches.

HIGH-POWER GUNS.

UNITED STATES.

POWDER TEST OF THE U. S. NAVY 8-INCH B. L. R.

This gun is of 35 calibres and is one of four forming the main battery of the U. S. S. *Baltimore.* This test took place at the Naval Proving Grounds near Annapolis in March of this year with the following results:

No. of shot.	Powder charge.			Weight of projectile.	Muzzle velocity.	Chamber pressure (tons per sq. in).
	Weight.	Kind.	Specific gravity.			
	Lbs.			*Lbs.*	*f. s.*	
1	80	BP	1.835	250	1,820	9.8
2	100	BP	1.835	250	2,012	12.7
3	106	BP	1.835	250	2,027	13.1
4	110	BP	1.835	250	2,129	15.5
5	80	BP	1.830	250	1,787	9.6
6	100	BP	1.830	250	2,029	13.4
7	102	BP	1.830	250	2,059	14.3
8	105	BP	1.830	250	2,100	15.6

A comparison of this gun with guns of nearly corresponding calibre in use in foreign navies may be of interest.

Nation.	Calibre of gun.	Total weight.	Length of bore.	Powder charge.	Weight of projectile.	Ratio of powder to projectile.	Muzzle velocity.	Muzzle penetration in steel.	Muzzle energy.	Energy per ton of gun.
	In.	*Tons.*	*Cal.*	*Lbs.*	*Lbs.*		*f. s.*	*In.*	*f. t.*	
England	8	14	30	118	210	1.78	2,200	14.7	7,048	503
Germany	8.24	13	32	103.6	308.6	2.98	1,738	13.4	6,464	497
United States Navy	8	13.1	35	110	250	2.27	2,129	15.8	7,855	600

Formula for penetration in steel: $E^{0.7} = (6.99066)\dfrac{p^{\frac{1}{2}}v}{a^{\frac{3}{4}}}$

ENGLAND.

The past year has been prolific of discussions and criticisms of English ordnance which have resulted in producing a general feeling that the design and construction of the large guns now being supplied to the English naval service are faulty, and this feeling has become almost a certainty since the publication of the newspaper reports of the trials of the *Victoria's* 110-ton guns.

This, if true, is a very serious state of affairs for the first naval power of the world, and we feel that a condensed resumé of the points bearing on this subject will not be out of place.

It has been stated that at the works of one firm alone, one 105-ton gun, one XII-inch, two X-inch, and two VIII-inch guns have had to be condemned while undergoing proof: that out of twenty-six 9.2-inch guns submitted to proof, five split their liners; and that two of the 67-ton guns had their liners disabled after but a few rounds. A 12 inch gun mounted on the *Colossus* had an accident happen to either its tube or liner and had to be replaced by another of the same calibre. The latest pattern of the 67-ton gun is of a different design from that first adopted, the principal change being an additional muzzle coil which augments the weight of the gun considerably. From the nature of this change it is but reasonable to suppose that this gun, as originally designed, did not prove as successful as was anticipated.

The results of the trial of the *Victoria's* 110-ton guns lead to the belief that all the guns of this class are unreliable. Of the nine guns of this calibre so far constructed Nos. 1 and 2 are mounted on the *Benbow*, and Nos. 7 and 8 on the *Victoria*. These last differ from all the others in that, since the failure of the *Victoria's* original pair of guns, Nos. 4 and 5, they have each had the chase strengthened by an additional long hoop. Two of the remaining guns are to be mounted on the *Sanspareil.*

English papers have stated that the 9.2-inch wire-wound guns have already shown a tendency to droop. The 6-inch, solid cast, nickle steel gun ordered by the British Admiralty from Jessop & Co., has not yet been tested.

Two hundred and eighty-one guns were issued to the naval service last year, making a total of 1,293 breech-loading rifle guns, ranging in calibre from 4 inches up to 16.25 inches, mounted afloat on the first day of this year, with 169 additional in reserve.

A 6-inch wire-wound, steel jacketed gun, constructed on the Longridge system, underwent successful trials at Woolwich in February of this year, during which, with a charge of 54 pounds of E. X. E. powder, an initial velocity of 2,149 f. s. was imparted to its 100-pound projectile with a corresponding chamber pressure of 19.6 tons per square inch.

FAILURE OF THE VICTORIA'S 16.25-INCH, 110-TON GUNS.

The ship trials of these guns took place last October, but up to the present time the full official details have not been promulgated. These were the Nos. 4 and 5 of the nine 110-ton guns made by Armstrong for the English Admiralty.

From foreign service journals we gather that No. 4 was fired but four times, and No. 5 twelve times. The projectiles used weighed 1,800 pounds each, while the charges varied from 720 to 960 pounds.

The No. 5 had been previously tried at Woolwich, where, after firing a few rounds, it was found to have drooped along the chase to the extent of over an inch at the muzzle. This defect was thought by the manufacturers to have been due to the peculiar form of carriage upon which the gun was mounted for proof. This drooping caused the chase coils to open out on top, and after driving steel wedges into these openings, the gun was turned over 180 degrees for further trials.

When afterward tried on board the *Victoria* these wedges were driven out, and the gun drooped in an opposite direction to that at first, to the extent of about 2½ inches at its muzzle. This caused a separation of nearly all the chase coils on top, with some to such an extent as to admit a man's little finger and so deep as to expose the gun tube to view. In separating, the upper parts of the coils all bent toward the muzzle, while the lower parts were pressed more closely together. The No. 4 gun was also said to have drooped at the muzzle, but not to so great an extent as No. 5.

In the annual statement of the First Lord of the Admiralty occurs the following in regard to these guns:

> One of the two guns of the original armament of the "Victoria" developed symptoms of a want of girder strength at proof, and after firing nearly 10 tons of powder in further tests, was returned to the contractors. In the opinion both of the naval, military, and civil experts who examined the gun, it could have been safely used on service, had the necessity arisen, but as it was not a perfect gun it could not be accepted for the service of the navy.

Naval writers have advanced many theories to account for the failure of this gun, but all unite in utterly condemning the design upon which it was constructed. As the matter now stands the result of this trial has proved the unreliability of this type of heavy gun, and we do not believe that the same design will be duplicated at any future time in guns for the English navy.

Some few authorities ascribe this failure to the poor material used in construction, but it must be admitted that the proof trials to which these guns were subjected were exceptionally severe, and that, while these resulted in the separation of the chase coils and the drooping of the muzzle, no cracks or other injuries are said to have occurred in the gun-tube or coils. The reason assigned for thus questioning the reliability of the metal employed in construction is that the steel used by the Elswick firm is manufactured by a process which produces the metal at a little more than half the cost of that of Krupp and Schneider, and from this fact the argument is advanced that it is not more than half as valuable for practical purposes. This difference is fairly well exemplified in the following table:

Gun maker.	Weight of gun.	Total cost.	Cost per ton.
Armstrong	111 tons.	$93, 160	$839. 28
Krupp	119 tons.	144, 750	1, 216. 38

The heavier gun referred to here is one of four constructed by Krupp for the Italian government; as bearing on the subject of the reliability of the metal used in the construction of the Armstrong gun, the following table will show that much more is demanded of the metal in the latter than in the former:

Maker.	Length of bore.	Powder charge.	Projectile.	Ratio of powder to projectile.	Chamber pressure.
	Cal.	*Lbs.*	*Lbs.*		
Armstrong	30	960	1, 800	1. 87	19. 5
Krupp	31. 7	727. 5	2, 028. 2	2. 79	14. 7

This increased tax on the Armstrong gun is due to the greater weight of charge, and is more, as was evidenced by the results of proof-trials, than the gun can stand for many rounds. As it is, the endurance of these guns has been frequently stated to be but 96 rounds. Admiral of the Fleet Thomas Symonds, in a communication to the London Times, quotes as follows from a letter received by him from a practical gunnery officer: "No 110-ton gun yet made would be safe after ten rounds of rapid firing (on service), nor 67-ton gun after twenty rounds;" and also, "I should put the life of the 110-ton gun at thirty rounds and a 67-ton gun at about fifty. I feel sure, however, that no 110-ton gun has ever fired ninety-six rounds, and would certainly not stand ninety-six rounds with full charges."

It is stated that one of the Krupp 119-ton guns has fired two hundred rounds since its acceptance by the Italian government, and that it is still fit for service.

The following additional comparison will show approximately the work performed by these two types of large guns:

Type.	Weight.	Muzzle velocity.	Muzzle energy.	Energy per pound of powder.	Energy per ton of gun.	Penetration in steel at muzzle.
	Tons.	*f. s.*	*f. t.*			*Inches.*
Armstrong	111	2148	57580	60	518. 9	30. 8
Krupp	119	1804	45970	63. 2	386. 3	27. 1

With the Krupp, the work demanded is greater in proportion to its powder-charge, but seems very small in proportion to weight of gun, although sufficient for all practical purposes, since, at the distance of a mile, it means a penetration of over 24 inches in steel.

The excessive work demanded of the Armstrong not only causes rapid wear, but also danger of absolute rupture. Erosion of the bore is common to all guns, but it would seem, from general report, to be unusually great in English guns, which is but a natural result of such heavy demands on the metal from the use of excessive charges.

THE BURSTING OF A 38-TON M. L. GUN ON BOARD H. M. S. AJAX.

On the 4th September, 1889, while at target practice, a 38-ton M. L. gun in the after turret of the *Ajax*, after being loaded and run out and before being discharged, suddenly burst.

The gun had been trained about one-half point forward of the beam. All that part of the chase outside of the turret broke off into many pieces, the part within the turret remaining intact. Two large pieces fell on deck just outside of the turret and a number of small pieces were blown forward, some the entire length of the deck. Although the gun was trained but slightly forward of the beam none of the pieces were blown aft—all went forward.

The injury done was about as follows: The forward turret received two large dents of about an inch in depth; two heavy iron bridge supports were cut away; an outer hawse-hole buckler was broken; the deck planking was scored in places, and several iron railing stanchions were badly bent.

There was no loss of life, as, fortunately, the crew were at quarters at the time and consequently the deck was clear of men.

The fracture was clean and showed no discernible flaws in the metal, and the joints of the coils of the gun did not seem to have been at all separated by the bursting.

The gun was a 12.5 inch, mark II, constructed on the Royal Gun Factory system with the inner of the two double coils forming the breech piece and the outer, the jacket. It took an 818-pound studded projectile and a charge of 210 pounds of P^2 (prismatic black) powder.

The fuze used was the Pettman general service, presumably of mark II. All the first pattern of this fuze (Mark I) were ordered converted to Mark II several years ago, but in so doing, many were so carelessly put together as to cause them to be regarded as dangerous. It is just possible that, through some mistake, one of these dangerous fuzes was used in the projectile which burst this gun.

Many causes have been advanced to account for this accident, but the court of inquiry ordered to investigate it found that the gun had been properly loaded with service charge and projectile and was about to be fired but burst before the primer was ignited. No blame was attached to any one and the occurrence was considered to have been purely accidental, arising from some defect in the time fuze of the projectile.

TRIAL OF THE TRAFALGAR'S 67-TON GUNS.

The ship trial of these guns took place in February last with the vessel under way.

Only service projectiles of 1,250 pounds weight were used. The service charge is 630 pounds of slow-burning brown powder.

These guns are so mounted that when pointed level the axes of the bores are but 3 feet 9 inches above the plane of the deck.

The following account of this trial is taken from the principal English service journals, the firing from the different guns having been carried out in the following order and under conditions as herein tabulated.

FORWARD TURRET.

Gun.	Charge.	Direction.	Elevation.	Recoil.
	Lbs.		°	*In.*
Right....	315	75 degrees before port beam	3	14½
Left.....	315	Ahead	1½	15½
Right....	315	75 degrees before starboard beam	(*)	13
Left.....	472½	Ahead	1½	29½
Right....	472½	82½ degrees before starboard beam	½	29½
Left.....	630	Ahead	3	47¼
Right....	630	67 degrees before starboard beam	1	47¾
Left.....	630	Starboard beam	13	52½
Right....	630	......do	13	49½

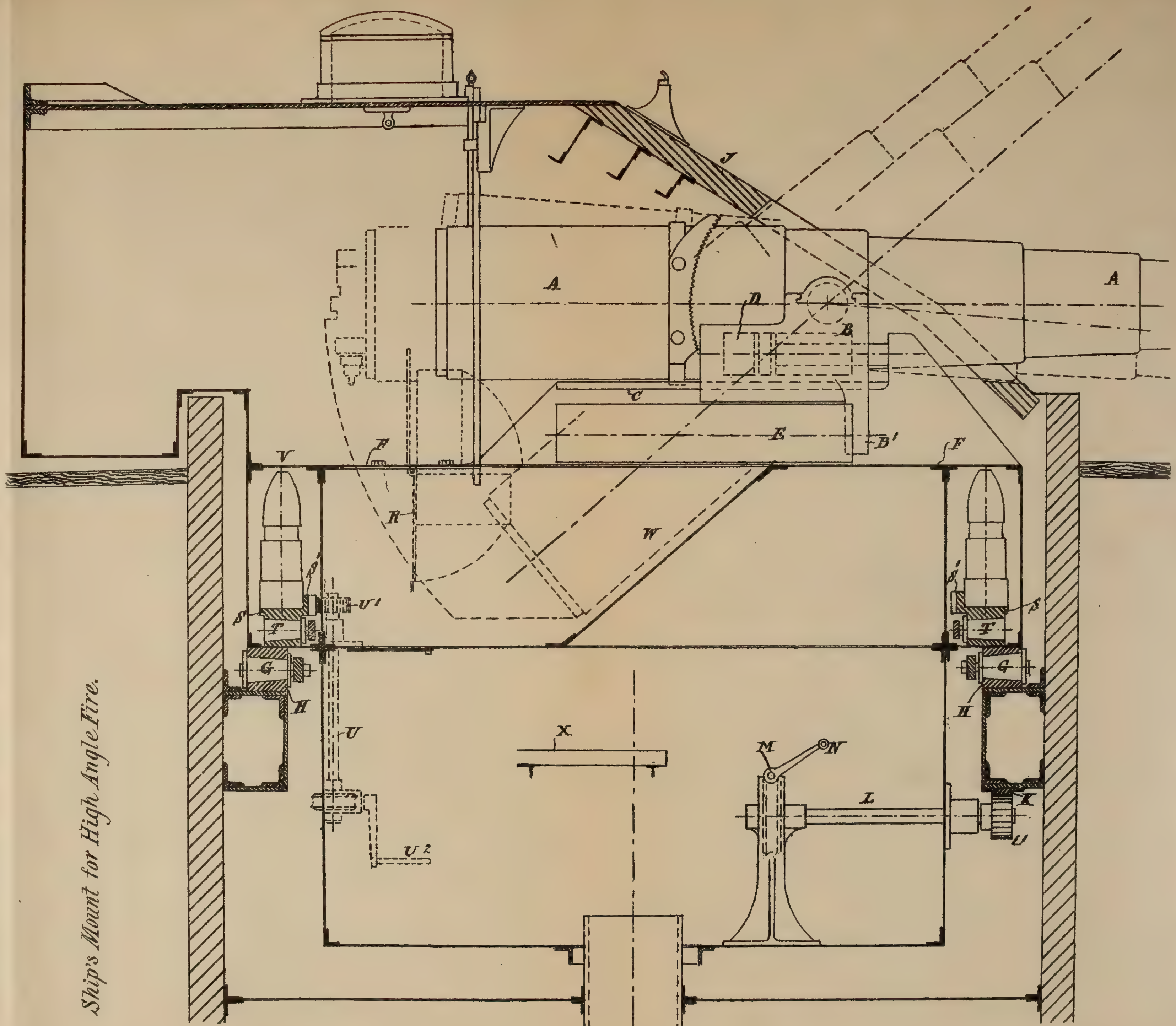
AFTER TURRET.

Gun.	Charge.	Direction.	Elevation.	Recoil.
Left.....	315	30 degrees abaft port beam	(*)	14
Left.....	472½	10 degrees before port beam	1	26¼
Left.....	472½	Port beam	7	28¾
Left.....	472½	5 degrees before port beam	10	29¾
Left.....	472½	10 degrees before port beam	13	32
Left.....	472½	20 degrees before port beam	3	27
Left.....	630	10 degrees before port beam	(*)	44¾
Right....	472½	Starboard beam	(*)	(†)
Right....	472½	......do	3	(†)
Right....	472½	......do	7	(†)
Right... Left....	472½	......do	10	(†)

* Horizontal.

† Unknown.

The first three shots, with which only half charges were used, are not reported to have caused any damage. The fourth shot blew off a nut attached to one of the cable covers. The blast in the fifth round got under this loosened plate and carried it away, besides detaching a whelp on the barrel of the capstan. With the sixth shot, which was the only one fired directly ahead over the full length of the forward



Ship's Mount for High Angle Fire.

deck, the blast caused a depression of about 2 inches in the deck near the water ridge in front of the turret, bending a beam below and fracturing one of the stanchions on the forward mess deck. The seventh shot shaved off a piece of the windlass bed.

The guns in the after turret were not fired at angles of less than 60 degrees from the fore and aft line. All newspaper reports state that shots Nos. 7, 8, 9, and 10 were fired for rapidity in nine minutes seven seconds; and in detail, from fire to fire, in three minutes two seconds, two minutes fifty-eight seconds, and three minutes seven seconds. If these reports are accurate these times are of but little use, as, upon an examination of the table we find that No. 7 was fired from the left gun with a full charge, while Nos. 8, 9, and 10 were fired from the right gun with only three-quarter charges. From this account we judge that there were four shots fired, and three spongings and loadings in nine minutes seven seconds. If to this we add the time necessary to train on a moving object we will find that the probable rate of fire from these guns will not exceed one shot in five minutes.

From the amount of damage done by the blast from No. 6 shot when the gun was elevated 3 degrees, we do not believe that the forward deck would stand many shots with full charges and with the gun at level.

HIGH-ANGLE FIRE FROM HIGH-POWER GUNS.

The English Government permitted the Elswick firm to erect a temporary structure on the gun-boat *Handy* for use in an attempt to obtain high-angle fire from the 9.2-inch. B. L. R. of 22 tons.

The accompanying plate is taken from the patent specifications of Mr. J. Vavasseur, the inventor of this mode of mounting.

A is the gun mounted on a carriage B, which has recoil-cylinders secured to it on each side as at D, the piston-rods of which are attached to the front ends of two slide girders C. The slide is horizontal and the gun is run out after recoiling by springs in a cylinder E, which are compressed during the recoil by a projection, B′, on the gun-carriage.

The slide forms the upper part of a turn-table F, which rests on a ring of live rollers on a fixed horizontal ring H, this ring being secured to the inner side of the armored barbette walls. The turn-table is intended to be revolved from below by hand-power by means of a toothed pinion L′, on a shaft, L, which gears into a fixed, circular, toothed rack K, and is operated by a crank-handle N.

Q is an ammunition tube. S is a circular frame on which the projectiles are carried and which is arranged to be revolved on a ring of live rollers T. The projectiles are here shown carried in a vertical position, but they can be carried in any manner.

The casing W, projects downward from the under side of the turntable sufficiently to permit the maximum elevation to be given to the gun, as shown by the dotted lines in the figure.

A good idea of this mount and its mode of working will be gained from the following extracts, taken from an account of a trial to which it was subjected in March last, which appeared in the London Times of April 1, 1890:

> The rotation of the turn-table and the consequent training of the gun are effected by crank-handles and gearing worked by six or eight men in a central compartment or well below the turn-table, where they can do the work under directions from No. 1 by means of an indicator, so that under fighting conditions not more than four men would be required around the gun. The mounting itself is of the Vavasseur type, having the trunnion-bearings formed upon two anti-friction steel buffer cylinders, the piston-rods of which attach to the front ends of two slide girders. The elevating gear, which is placed to the left of the mounting, admits of an elevation of 40°, or about 25° in excess of the *maximum* elevation ordinarily employed. At these excessive angles a large proportion of the explosive force of the powder charge is thrown downwards upon the slide and supporting structure of the ship or mounting. In order to lessen these downward forces as much as possible the slide is made horizontal, while at the higher angles of elevation, when great muzzle velocity and range of projectile would not be required, the gun is fired with reduced charges only. To provide a means of automatically running the gun out after firing, as the 10° inclination of the slide adopted for the purpose in other Vavasseur mountings is not desirable, two helical springs are fitted, one upon each side of the girder. Being compressed during the recoil, these springs store up sufficient energy to run the gun out along the horizontal slide. The greatest length of recoil allowed is 18 inches, while that in the ordinary 9.2-inch mounting, as fitted in the *Galatea* class, is about 38 inches.
>
> Attached to the right buffer cylinder is a toothed rack arranged to revolve a drum, the speed of which under the action of the springs is regulated by means of a friction-brake, whereby the speed of running out is also controlled. It is further arranged that the drum is not revolved during the recoil. Around another portion of the drum a wire cord is wrapped, by which means the motion obtained on running out the gun can be utilized for hoisting projectiles, the potential energy stored up in the springs thus serving a double purpose. It is, in fact, this divided utilization of the force of the recoil which gives occasion for the use of the brake to prevent the projectile being too suddenly hoisted. The loading of the gun is further assisted by a small winch which is placed in rear to the left of the mounting. The turn-table and mounting, and also the space for working the gun, is protected by being inclosed within a turret-like shield, having a sloping top from the rear to the front, through which the muzzle and a considerable portion of the chase of the gun protrudes. A sighting position raised and hooded is provided in rear and to the right, from which the laying of the gun can be controlled from within the shield. The supply of shot is arranged for on a novel plan. Below the flooring of the turn-table, and supported below the sides of the shield, is a circular rack capable of holding a large supply of projectiles, each of which is disposed horizontally and radially in a separate recess or holder. By this arrangement the structure of the turn-table includes a girdle or ring of projectiles ready for use. This ring is made capable of being revolved from within the shield so as to pass below a hinged flap or door in the flooring placed directly in rear of the gun. When it is required to reload, the flap is raised and the shot-rack rotated until a projectile comes to the opening, through which it is then raised by the hoisting gear. The gun may be used with full charges at ordinary angles of elevation, just as well as with an ordinary mounting. The gear was placed on board the ***Handy*** for experimental purposes by the inventors, the Elswick Company.
>
> The trial on Saturday was conducted by Captain Domville, in the presence of Admiral Nicholson (of the ordnance committee), Lieutenant Jellicoe (from the department of the director of naval ordnance), Commander Lloyd, Mr. Vavasseur, Mr. Don (who represented the Elswick firm), and Captain May. The shield was formed of

steel plates 1¼ inches thick, but for actual service it will have a thickness of 6 inches on the slope and 4 inches on the sides, and is designed as being specially suitable for cruisers and second-class iron-clads. It can also be arranged as a protection for guns mounted in barbettes. The gun used on the occasion was a Mark V 9.2-inch, firing a full charge of 175 pounds and Palliser and common shell weighing 380 pounds. Fifteen rounds were fired, with various charges and at different elevations for the purpose of testing the mountings under all practical conditions. Round 1, three-quarter charge, horizontal; round 2, full charge, 3° elevation, 18 inches recoil; rounds 3 and 4, full charges, 15° elevation; rounds 5, 6, and 7, three-quarter charges, at 5°, 10°, and 15° elevation, respectively; round 8 was fired with a three-quarter charge at 5° depression; rounds 9, 10, and 11, half charges, 25°, 32½°, and 40° elevation, the last giving a recoil of 14 inches; round 12, five-eighths charge, 30° elevation, 16½ inches recoil; round 13, three-quarter charge, 30° elevation, 17¼ inches recoil; round 14, three-quarter charge, 2° 50′ elevation, fired at a target for testing accuracy of sighting, recoil 17¾ inches; round 15, full charge, 1½° elevation, 18¼ inches recoil, also fired at a target with good result. The automatic shot-hoisting gear was not tried as the winch was fully equal to all requirements. The trial was successful in every respect, the only hitch occurring being the carrying away of the indicator on the recoil-press. There was a very noticeable absence of vibration in the mounting, and it was proved by actual experiment that the appliances rendered it possible to load, elevate, and fire with only one man to conduct the operations.

The weight of the platform is not given, but it is understood to be very great.

It will be noticed that firing at elevations greater than 15° was the exception rather than the rule in this trial.

FRANCE.

CANET GUNS.

These guns derive their name from M. Canet, the director of ordnance of the Société des Forges et Chantiers de la Mediterranée, who is the originator of the system upon which they are constructed.

The guns are built up at this company's extensive works at Havre of all French steel, that employed in the construction of tubes, hoops, and jackets being comparatively soft, quite elastic, and unusually tensile, and that for the breech mechanism, relatively hard.

The system is intended to include guns of from 3.6-inch calibre up to 16.8-inch, every one of which is to have six sub-divisions, each to be denominated by its length expressed in calibres. These are to be 20, 25, 30, 36, 43, and 50 calibres, and on these lengths will depend the velocities; these, as calculated, to run from 1,605 f. s. in the 20 calibre up to 2,624 f. s. in the 50 calibre.

The main characteristics of these guns are as follows: An inner tube extending the entire length of the gun, which, as compared with tubes of other types, is of great thickness. A jacket and a sleeve are shrunk upon the rear end of the tube and connected at the joint by a trunnion ring, which butts against a shoulder of the jacket and is screwed on to the sleeve. These extend well beyond the trunnions and, with a layer of broad steel hoops extending to the muzzle, give great longitudinal resistance, and enable the tube to withstand the greater pressures due to the use of smokeless powders. Over the jacket and sleeve are then shrunk one or more layers of steel hoops, which vary in number and thickness according to the size of gun. All parts vary gradually and uniformly in thickness, and all bearing surfaces are cylindrical. It is claimed that this method of assembling gives as great a resistance longitudinally as transversely.

The accompanying plate illustrates this method of assembling, and permits a comparison with the methods used by Krupp and Armstrong in their highest calibres.

The largest Canet gun now finished is one of three made for the Japanese Navy. It is a 32-centimetre (12.6-inch), which was constructed to use a smokeless powder charge, to give the same results as would be obtained from a charge of 616 pounds of brown prismatic. The following table, in which it is compared with the English 13.5-inch, 67 ton B. L. R., will show what results are anticipated from it in practice:

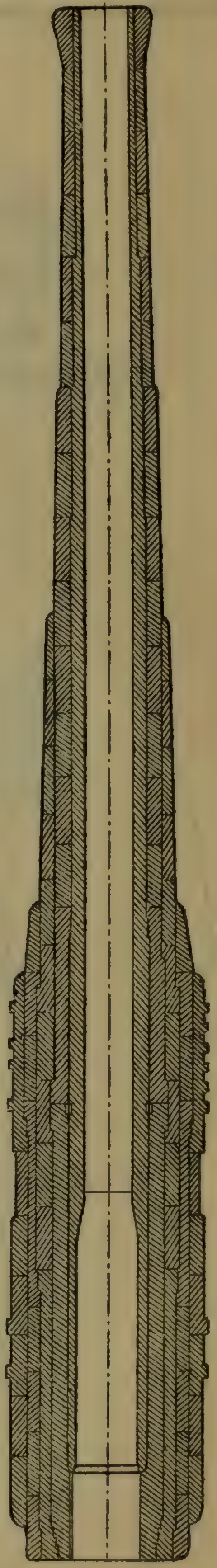
Type of gun.	Calibre.	Weight.	Length in calibres.	Powder charge.	Projectile.	Initial velocity.	Muzzle energy.	Energy per ton of gun.	Muzzle penetration in steel.	Thickness of metal over powder chamber.	Thickness of metal at muzzle.
	In.	*Tons.*		*Lbs.*	*Lbs.*	*f. s.*	*f. t.*		*Inches.*	*Inches.*	*Inches.*
Armstrong	13. 5	67	32	630	1, 250	2025	35, 540	530	26. 6	19. 5	4. 9
Canet	12. 6	65. 8	38	616	990	2300	36, 317	552	29. 1	17. 7	5. 4

The breech mechanism here described, Plate I, Figs. 1 and 2, is that applied to all the larger calibres. On one side of the rear face of the breech-plug is a toothed sector, B, which gears into a toothed rack, C. This rack is part of a bearing, D, which incloses a nut cast in one with a pinion, E. This nut works on the screw, F, which is supported by the bearings G, H, screwed into the face of the breech of the gun.

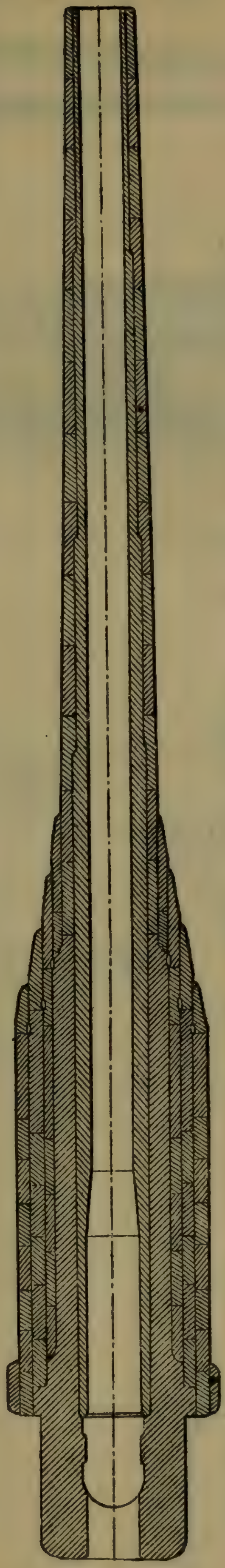
The teeth of the pinion E are helicoidal, and so cut as to gear into the screw threads of the breech-plug.

The worm-wheel I, mounted on the axis of the screw F, is fitted to receive a rotary motion from an endless screw, X, actuated by the lever K, through the shaft J.

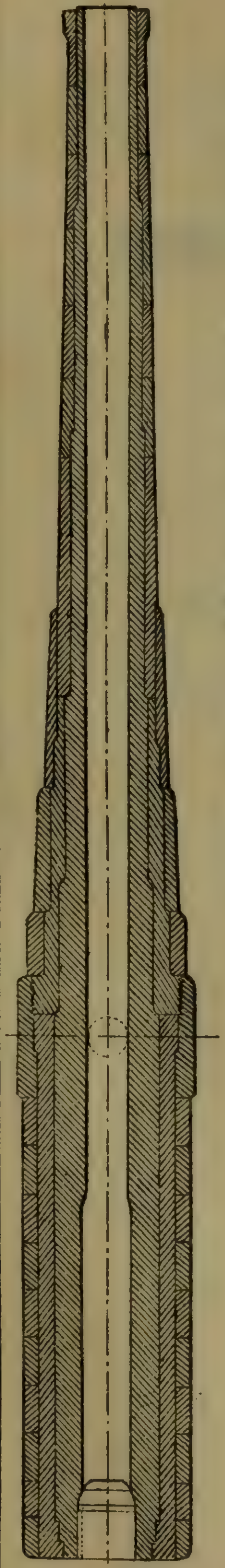
To open the breech, the lever K is pulled to the rear, thus transmitting a rotary motion through the endless screw X and worm-wheel I to the screw F. The bearing D is held in position by a traveler, m, sliding in a groove in the bracket, and the pinion E similarly held by lateral guides which embrace two of the teeth, so that neither can revolve, in consequence of which the nut and pinion-piece rise, causing the rack C to be forced up and around the sector B, and thus to revolve the breech-plug.



Armstrong 16.25 in. Gun, 111 tons.



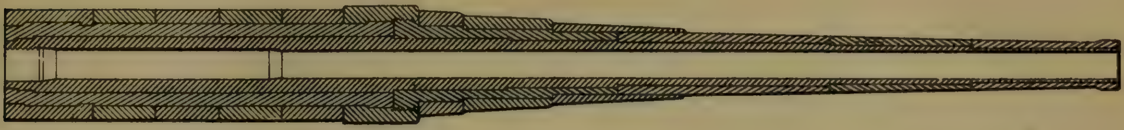
Krupp 40 c/m (15.75 in.) Gun, 119 tons.



Canet 34 c/m (13.39 in.) Gun, 65.8 tons.

PLATE 1

CANET 15 c/m B.L.R., 36 CAL.



BREECH MECHANISM.

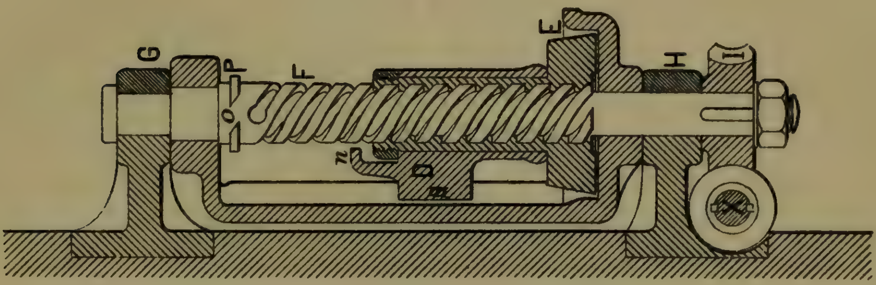


FIG. 2

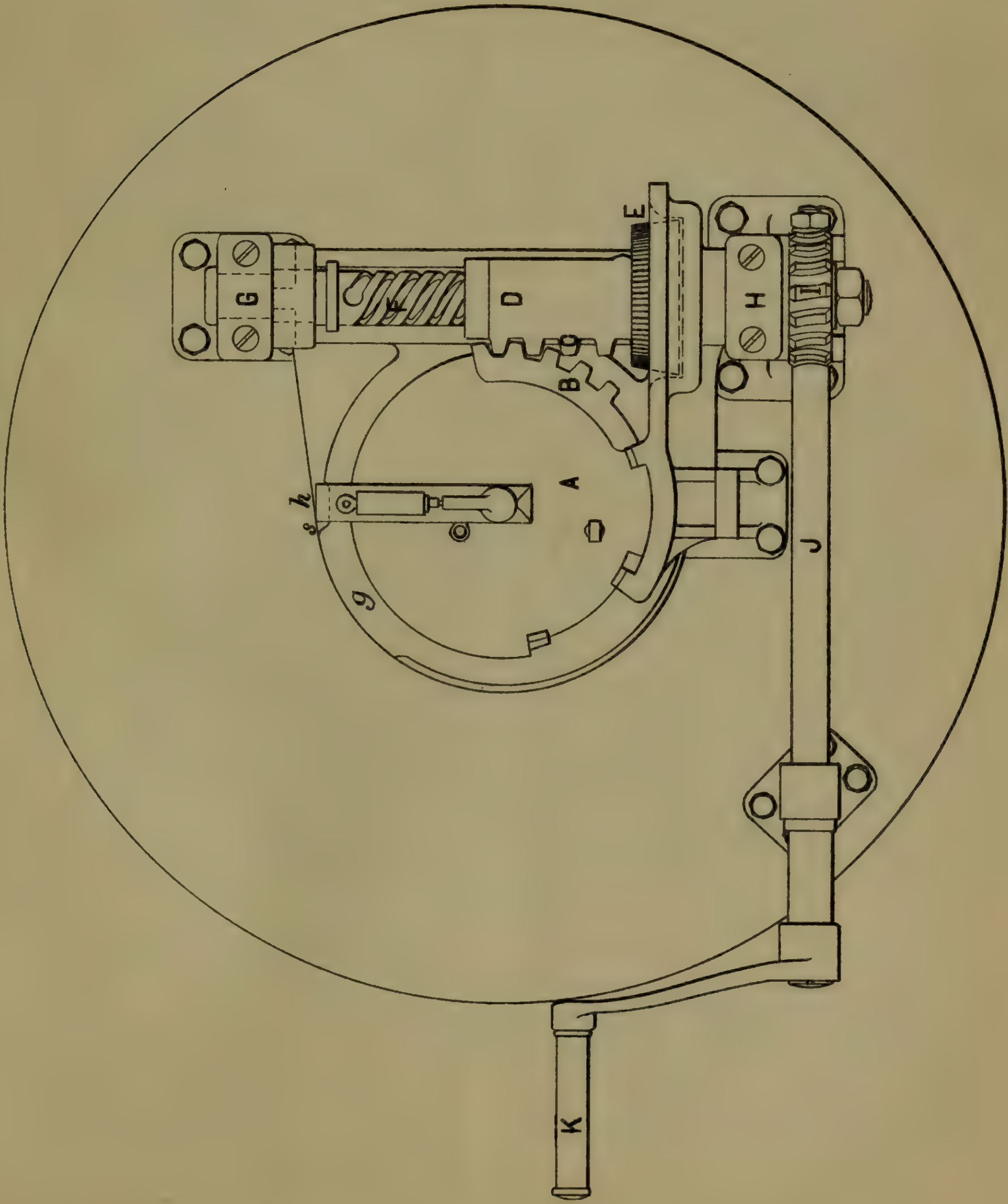
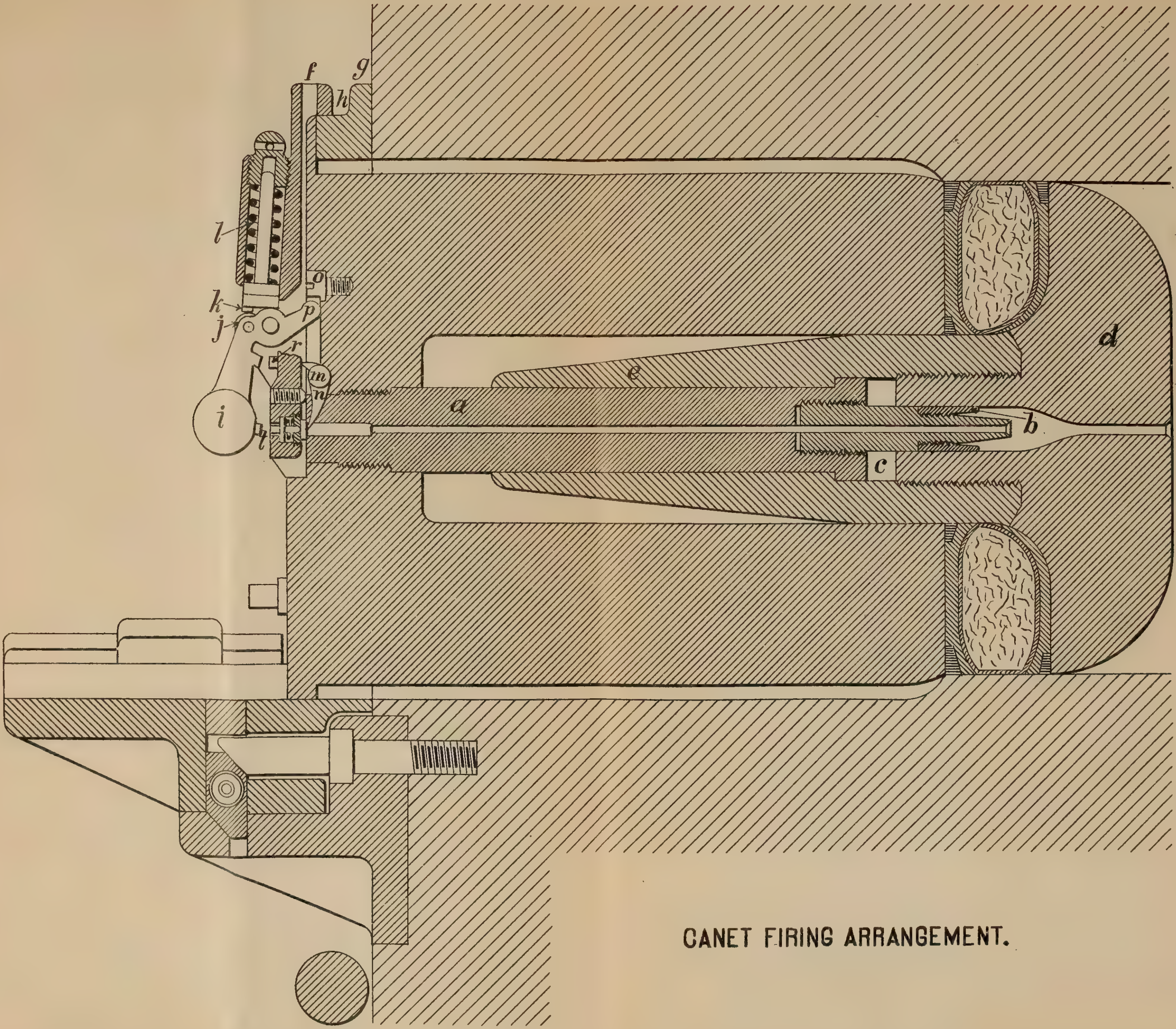


FIG. 1



CANET FIRING ARRANGEMENT.

When the threads of the plug are disengaged from those of the gun the bearing D will be found butting against the support G. In this position the guides which held the teeth of the pinion E are freed, and the rotation of the screw F will cause the nut to turn, and with it the pinion E, which will then engage the threads of the breech-plug and draw it out through the carrier-plate. At this point in the movement the hook *n* will pass through the slot *o* in the collar *p* and support the bearing. When the plug is completely withdrawn a bolt will lock it to the carrier-plate, with which the pinion E will form one, and will turn it and the plug around the axis of the screw F to the side of the breech of the gun. The breech can then be closed by an opposite movement of the lever.

The obturator used is a modification of the DeBange. A fixed axial stem, *a*, Plate II, is screwed into the rear face of the breech-plug, carrying a nozzle-piece on its front face, upon which is an obturating cup, *b*, to prevent the escape of gas to the space *c*. The obturator is in two parts, a mushroom, *d*, screwed on to a hollow spindle, *e*, that slides upon the axial stem.

The firing mechanism is also shown in Plate II. The firing-slide is in one piece, working in a slot on the rear face of the breech-plug. It has a lug, *f*, which rests against the outer edge of the face-plate *g*, the face-plate being so shaped that the lock can not pass into the firing position except when the breech is entirely closed; then the tail of the lock will come opposite the notch *h*, and permit the lock to descend. The hammer is provided with a roller, *j*, against which bears the lug *k* at the end of a rod against which pressure is exerted by the spring *l*.

On the breech-plug is fitted a horizontal axis *m*, carrying a two-armed lever, *n*, which acts as the primer extractor.

Suppose that the gun has been fired, and the breech-plug is now to be withdrawn preparatory to loading. As the breech-plug is revolved the lug *f* travels up the inclined plane *s*, Fig. 1, Plate I. The tail-piece, *p*, of the hammer takes against the stop *o*, and revolves the hammer *i*. The movement of the hammer forces the lug, *k*, of the firing pin, against the pressure exerted by the spring *l*, over the roller *j*, which cocks the piece. At the same time a stop attached to the slide bears against the short arm of the extractor, turning it sharply and causing the long arm to expel the primer tube. As the slide rises the nipple, *t*, is raised clear of the vent.

The lock-string is made fast to a trigger which is engaged in a tumbler (not shown). Upon pulling the string the firing-pin and spring are released and the hammer is driven down on the nipple. On the trigger are mounted four fingers which serve as safety firing appliances.

The following table gives the six subdivisions of the Canet 15-centimetre (5.9 inch) B. L. R.

Length in calibres.	Total weight.	Weight of projectile.	Weight of powder charge.	Calculated muzzle velocity.
	Tons.	*Lbs.*	*Lbs.*	*f. s.*
20	2.8	93	59.5	1605
25	3.5	93	59.5	1771
30	4.6	93	59.5	2001
36	5.5	93	59.5	2231
43	7.4	93	59.5	2427
50	8.4	93	59.5	2624

For the 30-calibre and 36-calibre guns, muzzle velocities of 2,034 f. s. and 2,661 f. s., respectively, have been obtained in actual trials.

Canet guns have already been mounted on several Greek men-of-war, and others have been ordered by Spain, Portugal, Chili, and Japan. Those on the Greek vessels are of 15 centimetres and 27 centimetres, 36 calibres in length, and, as a condition of acceptance, were required to give muzzle velocities of 2,250 f. s. and 2,260 f. s., respectively, with safe pressures.

The 32-centimetre (12.6 inch) guns for the Japanese cruisers now building will not be accepted if the velocities obtained on trial, with safe pressures, are less than 2,290 f. s.

The following details of firing tests of the 15-centimetre (5.91-inch) high power Canet gun of 36 calibres will be of interest. These tests took place this year, and, excepting those of the Schneider 15 and 24 centimetre guns, are the only ones reported up to the present time in which smokeless powder charges have been employed in high power guns especially constructed for their use.

Number of shot.	Weight of charge.	Kind of powder.	Weight of projectile.	Muzzle velocity.	Mean of chamber pressures. (tons per sq. inch.)
	Pounds.		*Pounds.*	*f. s.*	
1	22.0	BN. (Smokeless)	94.5	1,998	8.0
2	24.2	....do	93.8	2,149	9.9
3	26.4	....do	93.8	2,270	12.9
4	28.6	....do	94.7	2,411	15.3
5	30.8	....do	94.5	2,549	16.4
6	28.6	....do	94.8	2,408	15.3
7	30.8	....do	93.9	2,519	17.4
8	30.8	....do	94.7	2,532	16.4
9	26.4	....do	93.9	2,270	14.1
10	33.1	....do	93.8	2,648	20.4
11	33.1	....do	94.5	2,661	19.

TRIALS OF SCHNEIDER & CO.'S ALL STEEL GUNS.

The following tables contain the details of the trials of two calibres of these guns with charges of smokeless powder. The guns were constructed of Creuzot steel to use smokeless powders.

24-*centimetre B. L. rifle of* 36 *calibres.*

Date of trial.	Weight of charge.	Kind of powder.	Weight of projectile.	Velocity at 144.3 feet from the muzzle.	Chamber pressure. (tons per sq. inch.)	Recoil.
	Pounds.		*Pounds.*	*f. s.*		*Inches.*
May 8, 1890	88. 0	Smokeless BN. $\frac{24}{3}$	361. 6	2, 152	13. 9	11. 0
Do	99. 2	....do	361. 6	2, 342	15. 7	12. 4
Do	110. 2	....do	361. 6	2, 503	17. 9	14. 2
Do	110. 2	....do	361. 6	2, 493	16. 9	14. 2

Two chronographs were used and agreed very closely. The muzzle velocities should be nearly 50 f. s. greater than the velocities here tabulated.

15-*centimetre B. L. rifle of* 36 *calibres.*

Date of trial.	Weight of charge.	Kind of powder.	Weight of projectile.	Velocity at 144. 3 feet from the muzzle.	Chamber pressure. (tons per sq inch.)	Recoil.
	Pounds.		*Pounds.*	*f. s.*		*Inches.*
April 12, 1890 ..	13. 2	Smokeless BN.	88. 2	1, 164	2. 8	5. 1
Do	17. 6	.. do	88. 2	1, 450	4. 9	9. 7
Do	19. 8	....do	88. 2	1, 653	6. 5	13. 0
Do	24. 3	....do	88. 2	1, 935	7. 7	19. 7
April 29, 1890 ..	26. 5	....do	88. 2	2, 083	11. 7	16. 9
Do	28. 7	....do	88. 2	2, 280	13. 7	20. 5
Do	28. 7	....do	88. 2	2, 263	13. 9	20. 9
Do	30. 9	....do	88. 2	2, 368	15. 8	24. 8
Do	32. 0	....do	88. 2	2, 476	16. 7	26. 8

Two chronographs were used and agreed very closely. The muzzle velocities should be nearly 50 f. s. greater than the velocities here tabulated.

As a result of the above trials, Messrs. Schneider & Co. state that they are prepared to furnish guns and to guarantee minimum velocities as follows:

6-inch guns of 40 calibres length, to give a muzzle velocity of 2,674 f. s.

9 6-inch to 12-inch inclusive, to give muzzle velocities of 2,625 f. s.

CHINA.

Up to the present time two VIII-inch, 14-ton, B. L. R. have been assembled at the Kiangnan (Kao-Chang-miao) Arsenal near Shanghai, under an English superintendent formerly employed at the Elswick works.

The steel used in construction was imported from England, rough turned, and was afterwards bored, smooth-turned, and assembled at the above-named works.

At a trial of one of these guns a muzzle energy of 6,000 f. t. was developed with a charge of brown prismatic powder.

Material has been received from England to be used in the construction of a number of 10-inch and 12-inch guns.

24-CENTIMETRE (9.45-INCH) B. L. R.

Four guns of this calibre have been constructed at the Creusot-works for use in the coast defense of China. The following are the principal details:

Metal used in construction	Creusot steel.
Total length	36 calibres.
Total weight, including breech mechanism	20 tons.
Number of grooves of rifling	72
Weight of armor-piercing projectile	361.6 pounds.
Weight of powder charge	191.8 pounds.
Kind of powder	PB_2.

The reception trials of all these guns took place between September, 1889, and February, 1890, with the following tabulated results as the mean, for each gun, of all the shots fired:

Gun.	No. 1.	No. 2.	No. 3.	No. 4.
Weight of charge ... lbs.	191.8	191.8	191.8	191.8
Kind of powder	PB_2 of Sevran-Livry.	PB_2 d'Angoulême.	PB_2 d'Angoulême	PB_2 d'Angoulême.
Weight of projectile ... lbs.	361.6	361.6	361.6	361.6
Muzzle velocity ... f. s.	2,188	2,225	2,208	2,180
Chamber pressure ... tons to sq. in.	17	16.4	17	16.7

Schneider's composite obturator, a patented modification of the De Bange, was used, and worked perfectly. In these trials it was found that two men could change the elevation from —7° to +25° in 20 seconds, and could train the gun through 360° in three minutes.

GREECE.

TRIAL OF THE SPETSIA'S 27-CENTIMETRE (10.6-INCH.) CANET GUN.

The trial of this gun took place in October last, and was satisfactory in every respect. The obturation was perfect, and the breech mechanism worked smoothly and easily. The following are tabulated details:

Number of shot.	Weight of charge.	Kind of powder.	Weight of projectile.	Chamber pressure (tons per sq. in.).	Muzzle velocity.
	Pounds.		*Pounds.*		*f. s.*
1	209. 1	PB′ of Sevran Livry	445. 4	8. 8	2, 008
2	278. 4	do	553. 5	13. 6	2, 178
3	278. 4	do	551. 25	15. 9	2, 191
4	278. 4	do	553. 5	16. 0	2, 194
5	278. 4	do	441. 0	15. 5	2,355
6	209. 1	do	445. 4	10. 2	2, 030
7	209. 1	do	471. 9	11. 0	1, 903

It is interesting to compare this gun with the corresponding calibre in use in the French naval service:

Details.	French gun.	Canet gun.
Length ... calibres	30	36
Weight ... tons	28. 2	34. 6
Weight of charge ... pounds	200. 6	278. 4
Kind of powder	PB_2	PB′
Weight of projectile ... pounds	476. 2	551. 25
Muzzle velocity ... foot seconds	2, 034	2, 191
Muzzle penetration in steel ... inches	17. 4	21. 4
Chamber pressure ... tons per square inch	16	15. 9
Muzzle energy ... foot tons	13, 660	18, 459
Energy per ton of gun	482	533

PNEUMATIC GUNS.

The following is taken from the report of the "Dynamite Gun Board" upon the rapidity trials of the three 15-inch dynamite guns of the *Vesuvius* on October 9, 1889, in the Delaware River:

> The *Vesuvius* was taken into the channel eastward of Petty's Island, and during the trial lay at anchor with a spring from the quarter and with tugs to keep the direction.
>
> A mile had been laid off by a member of the Board and marked at each end by a buoy.
>
> The vessel's position was a little outside the lower limits of the mile, the distance from muzzles of guns to up-stream buoy being 5,360 feet. The breeze was in the direction of the line of fire, force, 2.
>
> One member of the Board, provided with a sextant, was stationed abreast of the

target buoy to note the fall of the shell. For the rapidity and endurance trials he moved to about 1,200 yards from the *Vesuvius*, to note approximately the falls. Another member was in the gun-room, to record pressures and losses of air. The third was on deck to note times.

The first shell fired was of the same type, dimensions, and weight as those used in the accuracy trials in January, 1889 (p. 386, No. VIII). It was ballasted with 200 pounds of sand and sawdust, and weighed complete 483 pounds.

The second and third sub-calibre shells were of a new pattern, recently adopted by the Pneumatic Dynamite Gun Company, 10½ inches in diameter, and weighing, ballasted, 504 and 506 pounds, respectively.

The projectiles for the rapidity and endurance trials were made only with a view to fulfill the conditions regarding weight in testing the breech and loading machinery. They were of iron, full calibre, 7 feet 1½ inches long, of rough exterior, and without rotating vanes. The centre of gravity was not placed so as to secure steadiness of flight or to develop the range attained by the sub-calibre shell. They were fitted with gas-checks less elaborate and efficient than those of the service shell, which will probably account to a certain extent for the variations in the losses of pressure, and in conjunction with the differences of weight and unsteady flight, for the variations in range.

The use of high explosives in the projectiles fired during the range and rapidity trial was waived by the Department.

After the sub-calibre shells were fired the storage reservoirs were pumped up to a pressure of 2,000 pounds. The compressors were then stopped and not started again during the trial.

The ship was in even trim; angle of guns elevation, 18°.

Firing began with guns empty and the breeches closed. The time from the word to begin until the firing of the first shot of the rapidity trial was one minute seven seconds, making the total time of loading and firing 15 shots, seventeen minutes fifteen seconds. Time from first to last shot, sixteen minutes eight seconds.

The mean of the losses by which the three sub-calibre shells were thrown for range was 86 pounds; the mean in the endurance trial was 98 pounds.

At end of trial the remaining pressure recorded in storage reservoirs was 1,300 pounds.

The capacity of storage reservoirs being 482 cubic feet, and of the firing reservoirs, 277 cubic feet, a simple computation shows that, neglecting variations due to changes in temperature, there was air enough left for nine more shots, assuming a loss for each shot of 98 pounds, which was the mean of those during the rapidity and endurance trial. Assuming a mean loss of 73 pounds, which threw the 506-pound shell 1,888 yards, there was air enough left for 13 more shots.

Had the compressors been kept in operation during the trial, as would be the case in action, the remaining number of shots would have been greater.

After the trial the guns, valves, seats and buffers, and the breech and loading machinery were examined and found to be in good working order.

All parts of the system, including valves and joints, were air-tight under the working pressure.

The chambers for handling of ammunition and service of the gun are conveniently disposed and arranged.

The safety of the crew from dangers incident to handling the shells and loading and firing the guns seems to be provided for. Stout bolts hold the breech section of each gun up in line with the rest of the barrel, so that in case of accident to the hydraulic machinery the section could not fall out of line. The firing-lever is interlocked with the breech mechanism so that it can not be pulled until the breech is closed and the bolts engaged. Conversely, the bolts can not be withdrawn until the firing-lever is locked. The stem of the operating piston is held by a clutch on the transmission rod, being released only as the latter is retracted by the action of the firing-lever, so that an accident of any kind to the bulb, range calculator, or other part of the operating valve could not cause accidental discharge.

No hang-fires occurred. The firing-levers are now pulled immediately without interruption the full distance for firing.

The Board states that the dynamite guns constituting the armament of the *Vesuvius* can throw shells containing 200 pounds or more of dynamite, or other high explosive, at least one mile, and that provision is made for varying the range at will within the statute mile down to 200 yards from the muzzle of the gun.

A tabular statement of this practice is appended. The column of this table which merits special study is that headed, "Pressure—Loss."

No attempt was made to secure accuracy of practice. It was only sought to lose enough air at each shot to carry a standard projectile well beyond the mile.

But the Board being of opinion that some assurance should be had that the loss of air pressure, representing, as it does, the energy put into the projectile, can be controlled within closer limits, ventures to call the Department's attention to this point for such action as may appear desirable, the *Vesuvius's* guns not having been tested in this respect.

Tabular report of firing of dynamite guns of the Vesuvius.

[S.—Starboard. M.—Middle. P.—Port. S. C.—Sub-calibre. F. C.—Full calibre.]

No. of shot.	Gun.	Time.	Projectile.		Pressure.			Flight.		Remarks.
			Nature.	Weight.	Initial.	Final.	Loss.	Character.	Range.	
		h. m. s.							*Yards.*	
1	S.	4 56 30	S. C.	483	750	670	80	steady	2,108	Ricocheted 300 or 400 yards. Straight.
2	M.	57 22	S. C.	504	750	645	105	....do	2,138	Entered water neatly.
3	P.	58 22	S. C.	506	750	677	73	....do	1,888	Do.
4	P.	5 34 42	F. C. plug	Average about 525. None less than 502, nor more than 540.	750	680	70	tumbled	1,300	Approximate.
5	P.	35 37	....do		750	676	74	....do	1,450	Do.
6	P.	36 30	....do		750	676	74	....do	1,450	Do.
7	P.	38 10	....do		750	674	76	....do	1,400	Do.
8	P.	39 05	....do		750	672	78	....do	1,400	Do.
9	M.	5 40 00	....do		750	645	105	....do	1,200	Do.
10	M.	40 56	....do		750	641	109	....do	1,450	Do.
11	M.	41 50	....do		750	636	114	....do	1,300	Do.
12	M.	42 57	....do		750	646	104	....do	1,400	Do.
13	M.	43 53	....do		750	654	96	....do	1,350	Do.
14	S.	5 45 09	....do		750	632	118	....do	1,600	Do.
15	S.	46 59	....do		750	638	112	....do	1,350	Do.
16	S.	48 34	....do		750	645	105	....do	1,350	Do.
17	S.	49 42	....do		750	630	120	....do	1,350	Do.
18	S.	5 50 50	....do		750	632	118	....do	1,400	Do.

The Secretary of the Navy afterwards sent the following letter to the president of the Pneumatic Dynamite Gun Company.

NAVY DEPARTMENT, *Washington, November* 22, 1889.

SIR: Referring to the contract entered into by the Pneumatic Dynamite Gun Company for the construction of the dynamite-gun cruiser *Vesuvius*, and to your communications of the 11th ultimo, in which you state that the vessel is completed in accordance with the requirements of the contract, and request final payment thereunder, including all reservations, except the special reservation of $20,000, I have to inform you that from an examination of the papers on file in the Department relating to the trials of the vessel and her armament, it appears that my predecessor, in a communication addressed to the Pneumatic Dynamite Gun Company, under date of March 2, 1889, informed the company that the trials of said vessel had been successful; that she met the requirements of the contract, except so far as such requirements relate to the conditions to be fulfilled by her armament, the tests of which were not then completed; that the requirements of the contract, so far as the same relate to the accuracy of the vessel's guns, had also been fulfilled to the Department's satisfaction, and that the results of the other tests of the armament, as called for by said contract, would be communicated to you when such tests were completed by the Board appointed for the purpose of conducting the same. It also appears that the other tests referred to were such of those embraced in sub-division 6 of the eighth clause of the contract which provides that the guns constituting the armament of the vessel shall throw shells containing 200 pounds of dynamite or other high explosive at least 1 mile, and that each gun shall be capable of being discharged at least once in two minutes, under the conditions therein stated, as were not included in either the report of the Board upon the accuracy of the gun, or the first report, dated February 25, 1889, of the Board appointed to witness and report upon the trial of her armament, but were referred to in the latter report as the subject of a further report to be made by that Board. A copy of the further report of the Board, embracing the other tests referred to, dated October 18, 1889, was furnished you on the 26th of the same month.

The requirement that the guns shall be capable of being discharged once in two minutes appears, by the last-mentioned report, to have been performed, and while, in the same report, the Board states that the dynamite guns constituting the armament of the *Vesuvius* can throw shells containing two hundred pounds or more of dynamite, or other high explosive, at least 1 mile, it is not shown by said report, or by any other papers on file in the Department relating to this subject, that any shells containing dynamite or other high explosive have been fired from the guns constituting the armament of the vessel, and the Department is informed that no shells containing explosives have been fired from any of her guns.

Both the statute authorizing the construction of the vessel, and the contract, require that the horse-power developed by the engines shall not be less than 3,200, but the papers and reports relating to the trials of the vessel do not show that this requirement was fulfilled, the only official data relating to the horse-power developed being contained in the report of the Board appointed to determine the speed of the vessel, and by which it appears that the horse-power developed by one engine only is reported.

It will be seen from the foregoing that the specific requirement of the statute, that the guns shall be capable of throwing shells containing 200 pounds of dynamite, or other high explosive, at least 1 mile, has not been fulfilled, and that another specific requirement thereof, that with reference to the horse-power, is not shown to have been fulfilled.

Under these circumstances, and in view of the specific requirements of the statute authorizing the construction of the vessel, that her engines shall develop "three thousand two hundred horse-power," and that she shall be equipped with three pneumatic dynamite guns guaranteed to throw shells containing 200 pounds of dynamite, or other high explosive, at least 1 mile, it must, before the vessel can be accepted under the provisions of the ninth clause of the contract for her construction, be demonstrated, upon trials, that the vessel and her armament are capable of fulfilling said requirements, I have, therefore, to request that a shell containing 200 pounds of dynamite, or other high explosive, be thrown at least 1 mile, by each of the guns constituting the vessel's armament; that she be subjected to a trial to demonstrate the capacity of her engines to develop 3,200 collective indicated horse-power, and that you inform the Department of the date or dates on which the vessel and her armament will be ready for such trials, in order that the necessary instructions may be issued to boards of officers to witness and report upon the same.

Very respectfully,

B. F. TRACY,
Secretary of the Navy.

Mr. S. D. SCHUYLER,
President, Pneumatic Dynamite Gun Company, No. 71 *Broadway, New York, N. Y.*

The following is the report of the final test of the guns of this vessel:

PHILADELPHIA, PA., *March* 14, 1890.

SIR: In obedience to the Department's order of the 4th instant, appointing a Board to witness and report upon a test of the pneumatic guns of the *Vesuvius*, the Board has the honor to report as follows:

On March 13 the Board assembled on board the *Vesuvius* off Chester, Pa., and proceeded in her to a position in the Delaware River eastward of Marcus Hook Bar. The range was laid off by a member of the Board and marked at each end by a buoy and flag. Before beginning the official trial a few blank shots and two heavy dummy projectiles were fired from each gun, to verify the settings of the range-valves required to obtain the desired air losses.

The projectiles were of sub-calibre; their characteristics were as follows:

	No. 3.	No. 4.	No. 5.
Weight, empty ....lbs..	277	278.5	272.5
Gun cotton ....do..	204	204.5	204
Fuze ....do..	9.5	9.5	9.5
Wood packing ....do..	14	18	18.5
Total weight ....do..	504.5	510.5	504.5
Length ....inches..	90.25	90.25	90.25
Diameter ....do..	10.5	10.5	10.5
Centre of gravity from front end ....do..	$37\frac{11}{16}$	$37\frac{9}{16}$	$37\frac{9}{16}$

The charge in each case included 50.5 ounces of dry cotton primers, the remainder was wet, average moisture about 35 percent.; all of it was made at the United States Torpedo Station, Newport, R. I.

The wood packing was put in at the rear end of the shells to fill up, their capacity being a little in excess of that necessary to stow the charge.

A mechanical fuze was used, and delayed action was obtained in the first and second shots by time trains intended to burn, respectively, 5.5 and 1 seconds. The third was intended to detonate on impact. The first delay was noted with a stop-watch, and is considered correctly given below to within one quarter-second; the second delay was estimated.

During the trial one member of the Board was stationed on board the *Vesuvius* to note position and watch the flight. The other members were in a tug abreast the target, to note points of fall. As the breeze was across the line of fire and the current running diagonally, it was impracticable to fire when at anchor; and for the same reason the vessel could not be kept accurately in position at the upper end of the range; the position was carefully noted at each shot. The distances to the points of fall beyond the lower buoy were estimated.

The *Vesuvius* was on even trim; elevation of guns, 18 degrees.

The record of the firing is given in the following table:

No. of projectile.	Gun.	Pressure.		Loss.	Time of flight.	Action of fuze.	Character of flight.	Distance from target.	Fall beyond target.
		Initial.	Final.						
		Pounds.	*Pounds.*	*Pounds.*	*Seconds.*	*Seconds.*		*Feet.*	*Yards.*
5	Middle	750	667	83	11	5. 25	Steady.	5, 300	350
4	Starboard	750	658	92	11. 75	.75 to 1	..do	5, 500	400
3	Port	750	644	106	11. 75	Impact.	..do	5, 500	500

The first shell evidently struck the bottom, as a mass of earth several cubic yards in size was thrown up in the air.

At the second shot a clean column of water was thrown up about 250 feet.

At the third shot the flash of the detonation was seen above water, and the concussion was that of a detonation in air.

This record shows that a shell containing 200 pounds of dynamite or other high explosive was thrown at least one mile by each of the dynamite guns constituting the vessel's armament. The ranges attained were considerably over the mile, the actual distances, to a fairly close approximation, being respectively 2,116, 2,233, and 2,333 yards.

A report will be forwarded later of the necessary expenses to which the contractors were put in conducting the trial, except the cost of the ammunition used.

Very respectfully, your obedient servants,

ROBT. F. BRADFORD,
Captain, U. S. N., Senior Member.
H. N. MANNEY,
Lieutenant Commander, U. S. N., Member.
SEATON SCHROEDER,
Lieutenant, U. S. N., Member.

Hon. B. F. TRACY,
Secretary of the Navy.

PNEUMATIC GUNS ON THE GRAYDON TYPE.

These guns, which are to be manufactured in England, have been named "Aerial Torpedo Throwers" by their inventor.

The general form is that of a tube mounted on a carriage or platform, with accompanying air reservoirs and loading mechanism.

A revolving torpedo thrower of five barrels has also been designed for a field piece, and is to throw shells containing from 4 to 6 pounds of dynamite at the rate of 75 shots per minute.

These torpedo throwers are to range in calibre from 3 to 21 inches, throwing shells containing from 6 pounds to 1,200 pounds of dynamite or other high explosive up to a distance of three miles by means of air pressures running up to 5,000 pounds per square inch. The design of the projectile permits the use of a comparatively short tube, that for the 15-inch gun to be not more than 34 feet in length. It is expected that this gun, with its complete outfit, will cost about $50,000.

Various fuzes are to be used—electric, safety, time, and contact. The electric fuze depends on the power exerted by the pressure of water at varying depths, and is so constructed that the firing-plunger can be set so as to automatically unlock at any desired pressure.

It is intended to so mount these guns that they may be trained and elevated and depressed. The construction of trial guns has already been commenced.

PROJECTILES.

ARMOR-PIERCING PROJECTILES.

Those manufactured by the Firminy and Holtzer processes are still esteemed the best. The following table contains a list of a few armor-piercing projectiles exhibited at the Paris Exposition of 1889, each of which had been previously fired against an armor plate:

Projectile and maker.	Plate fired against.		Results of trials.
	Material.	Thickness.	
		Inches.	
Firminy, chrome steel, 16.5-inch of 1,720 pounds.	Iron	19.7	Perforated plate and went 328 yards beyond.
Holtzer, chrome steel, 16.5-inch of 1,720 pounds.	..do	19.7	Perforated at angle of 20°. Point uninjured. Projectile set up and bulged very slightly.
St. Chamond, chrome steel, 16.5-inch of 1,720 pounds.	..do	19.7	Perforated at angle of 20° with the normal, and uninjured.
Firminy, chrome steel, 10.6-inch of 476.2 pounds.	..do	9.8	Perforated and went 765 yards beyond.
Holtzer, chrome steel, 10.6-inch of 476.2 pounds.	Steel......	9.8	Perforated. Projectile intact. Very slightly set up and bulged. Point a little out of line.
St. Chamond, chrome steel, 10.6-inch of 476.2 pounds.	..do	9.8	Perforated plate. Projectile intact.
Do....................	..do	11.8	Do.

The following is an account of a reception trial to which a 13.5-inch armor-piercing shell was subjected in England in September last.

The shell, which weighed 1,256 pounds and did not contain an explosive bursting charge, was manufactured on the Firminy process by Messrs. Thos. Firth & Sons, of Sheffield. It was fired at a target built up as follows: One compound armor-plate 6 ft. square by 18 in. thick, one wrought-iron plate 6 ft. square by 6 in. thick, 13 feet of oak backing composed of layers of beams 1 foot square, and at the rear an old target composed of four 8-inch wrought-iron plates securely bolted together with 5 inches of oak between each. The range was 124 yards and the projectile had a striking velocity of 1,950 f. s.

The projectile passed entirely through the 18-inch plate, the 6-inch plate, and the oak backing, and buried itself in an old hole in the rear target made by a 16-inch Palliser shot, with its base flush with the face of the rear target. On being withdrawn the projectile was found to have struck against a 16-inch Palliser shot which had been previously fired into the old target and had remained there, and its point had penetrated this shot 4 inches. The head of the armor-piercing projectile was entire, with its point intact and without cracks, but its base was fractured radially in four places.

The lot of one hundred and twenty projectiles, of which this was one of the number to be tested, was accepted without further trials.

A Krupp 6-inch armor-piercing projectile, with a striking velocity of 1,864 f. s., is reported to have perforated a 9-inch compound plate without being either cracked or deformed.

HIGH EXPLOSIVE SHELLS.

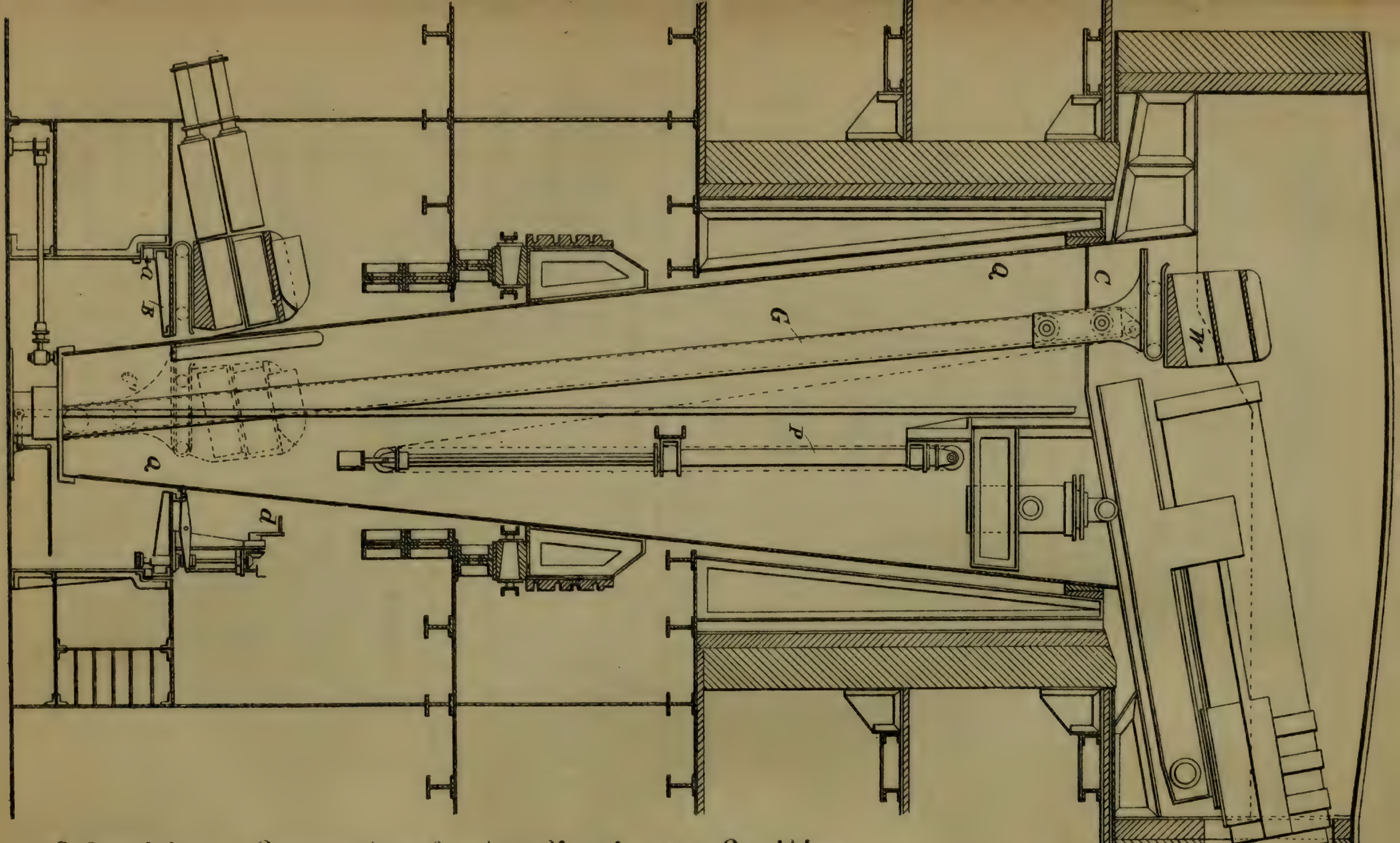
Several firms are making a large number of these shells in France, presumably to contain mélinite charges. These vary in length from 4½ to 5 calibres, and are evidently intended to contain comparatively large bursting charges.

AMMUNITION HOIST.

The slow rate of fire of turret and barbette guns in use afloat is principally due to the necessity for bringing the gun, after each fire, to one fixed loading position. The working of the English 110-ton gun affords a good illustration.

As soon as this gun is fired the turret is trained around to bring the gun into the loading position, where it is given its maximum elevation, 13°, in order to place its breech in line with the ammunition car. By hydraulic power the breech plug is then unlocked, withdrawn, and carried to one side. These operations, added to those necessary to load, close the breech, and give the required elevation and train, would probably cause the rate of fire of this gun to be not more than one shot in six minutes under the most favorable circumstances. In other words, between two consecutive shots from this gun, two vessels approaching each other at a speed of 16 knots each would decrease their distance apart by 3.2 nautical miles.

Methods permitting the loading of guns in any position are now being adopted abroad. One of these, designed by M. Henri Schneider, the manager of the Creuzot Works, is represented in the accompanying plate. In this method, which is applicable to one or more guns in a turret or barbette, the ammunition car, W, is fitted on a carriage, C, arranged to be hoisted or lowered on the inclined elevator guides, G, by means of a combination of chains and pulleys operated by a hydraulic press, P. These guides are in a central conical tube, Q, which has at B, on the ammunition deck, a platform constructed to revolve on rollers, *a*. This platform is arranged to revolve either independently of or connected to the tube Q, this tube always revolving with the turret,



Schneider's Apparatus for Loading in any Position

To load the gun, the ammunition car having been lowered to C′, and the platform, B, connected to revolve with the turret, run the car on the platform and disconnect from the tube. Revolve the platform to where the ammunition is and charge the car. Then revolve back to the original position and lock platform to tube by means of the lever *d*. Then wheel the car on its carriage and by means of the hydraulic press hoist it to the breech of the gun.

M. Canet has designed an excellent arrangement for the same purpose, which will be placed in the Japanese cruisers being constructed by the Forges et Chantiers—the *Matsusima* and *Itsukusima*—for their 32 centimetre (12.6-inch) 38 calibre guns.

ILLUMINATED SIGHTS FOR NIGHT USE.

A system of electrically illuminated night sights is now in use for guns of all sizes, on many vessels of the English navy.

The sights are so constructed that they can be put on or removed from the gun in a very short time.

The front sight consists of a metal socket inclosing a very small cone of pale green glass, point up, and with only the rear half showing. Under this is a small incandescent lamp, the light from which shines up through the base of the cone and is then reflected to the rear.

The rear sight is similar except that, instead of the cone, there is a metal cross-bar with a V-notch in the middle, and a polished under surface from which the light, which first passes through a ruby-colored glass, is reflected.

In sighting, the point of pale green light is brought to the bottom of the V-notch of the rear sight, and the line of ruby-colored light brought into coincidence with it.

No difficulty is experienced in bringing these lines of light into coincidence, and the sights are said to work satisfactorily.

The electric current used is local for each gun, and is supplied by a battery of two elements contained in a water-tight box, so arranged that when turned upside down the battery is out of action and can be kept so until the sights are needed for use.

It is said that the light can be modulated to varying intensities, so as to suit the eye with any degree of darkness of night, by two circular resistances placed on the outside of the box, and connected by a double-wire lead with the front and rear sights, respectively.

THE FISKE RANGE-FINDER.

This instrument, the invention of Lieut. B. A. Fiske, U. S. Navy, has been mounted upon several United States naval vessels, and has been officially tried by a naval Board.

In order to fully explain the principles upon which it is designed we can do no better than to give them as set forth in Lieutenant Fiske's patent specifications, as follows, the figures referred to being found in Plate I:

My invention consists in a new method of finding the range and position of a distant object, which depends upon the determination of a fractional portion of a conducting body bearing in length a ratio to the angle included between two lines of sight directed upon said distant object and the measurement of the electrical resistance of said length.

The accompanying drawings are (Figure 4 excepted) all electrical diagrams, not drawn to scale, and symbolically represent the invention. In Fig. 1 is shown a Wheatstone bridge, in one member *a* of which is arranged a body of conducting material in arc form and a movable arm traversing the same. In Fig. 2 is shown a Wheatstone bridge having arcs and movable arms arranged in two members *a b*. In Fig. 3 is shown a Wheatstone bridge in which arcs connect adjacent members, as *a c* and *b d*, and movable arms sweeping over said arcs are connected to the battery. Fig. 4 is a mathematical diagram illustrating the method of determining the angle ATC. Fig. 5 shows a disposition of the range-finder in connection with a galvanometer, and Fig. 6 the same in connection with a telephone.

Similar letters of reference indicate like parts.

In Fig. 1, let *a b c d* represent the four members of an ordinary Wheatstone bridge, and *g* the transverse member, in which is connected the galvanometer *g′*. A battery *f* is also connected to the bridge in the usual way. In the members *c* and *d* are placed the fixed resistances *c′* and *d′*, and in the member *b* the variable resistance *b′* also, as usual. One wire from battery *f*, however, connects to the end of member *c*, and also to the pivot *l* of a swinging arm *i*. The extremity *k* of arm *i* moves over and maintains electrical contact with an arc *h* of conducting material, which has one extremity *j* connected, as shown, to the member *a* of the bridge. It is obvious that when the arm *i* is in the position shown in full lines in Fig. 1 then the current will traverse the whole arc *h*, and when said arm is in the position indicated by dotted lines, Fig. 1, then the arc *h* will be cut out and the current will pass directly to member *a*. Now assume the arc *h* to be made of such material and so proportioned that its electrical resistance to a current traversing it will be proportional to the length of arc included between the contact end *k* of arm *i* and the connecting point *j* of member *a* with said arc. Therefore the resistance interposed in the member *a* of the bridge will be commensurate with the angle *j l k*, and if this resistance be known the angle is also known. Let it now be assumed that the galvanometer *g′* and variable resistance *b′* be located at some point distant from the moving arm *i*, from which said arm is invisible or inaccessible. Clearly, then, an observer stationed at the galvanometer *g′* and resistance *b′* can, by noting the galvanometer and adjusting the resistance in the usual way, determine the resistance equilibrating any position of arm *i* along the arc *h*, and so discover the angle of adjustment of said arc; or, having adjusted the resistance *b′* at some given figure, the observer may, by simply noting the galvanometer or any other suitable indicating device, visual or audible, determine when the arm *i* is placed at a desired angle corresponding to the adjusted resistance, and this indicating device may obviously be at the place where the moving arm is located, so that the operator there may thus know when he has placed the arm at the predetermined point or at the distant station, so that the operator in charge of the resistance *b′* may know that the arm has been adjusted properly; or two indicating devices in the same circuit may give warning to both operators, as above, simultaneously.

Various practical applications of this apparatus will readily suggest themselves to those skilled in the art. Thus, for example, the elevation or training of a gun may thus be determined or recognized from a distant point, the longitudinal axis of the gun corresponding to the arm *i*.

Referring now to Fig. 2, it will be apparent that in lieu of the variable resistance *b′* in the member *b* there is arranged an arc *h′* and swinging arm *i′*. The arc *h′* is connected at one end *j′* to the member *b*, and the swinging arm *i′* makes contact at one

PLATE I.

Fig. 1.

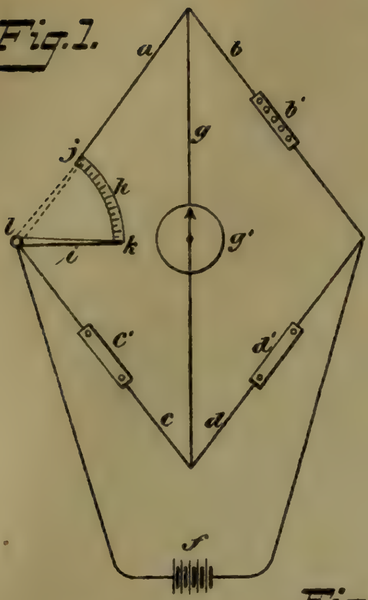


Fig. 2.

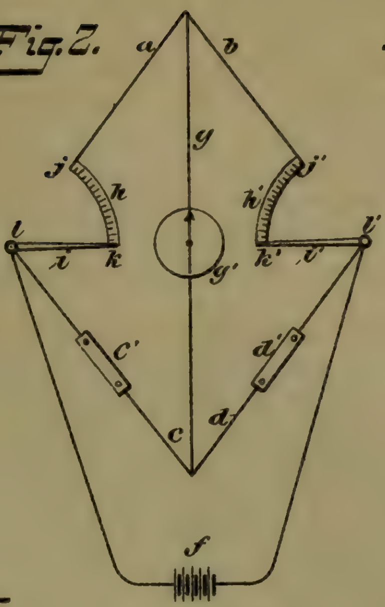


Fig. 3.

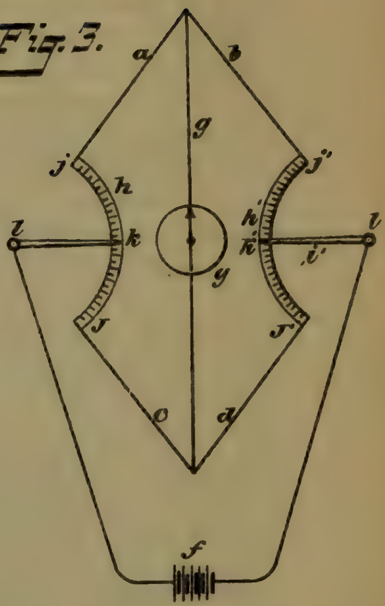


Fig. 5.

Fig. 4.

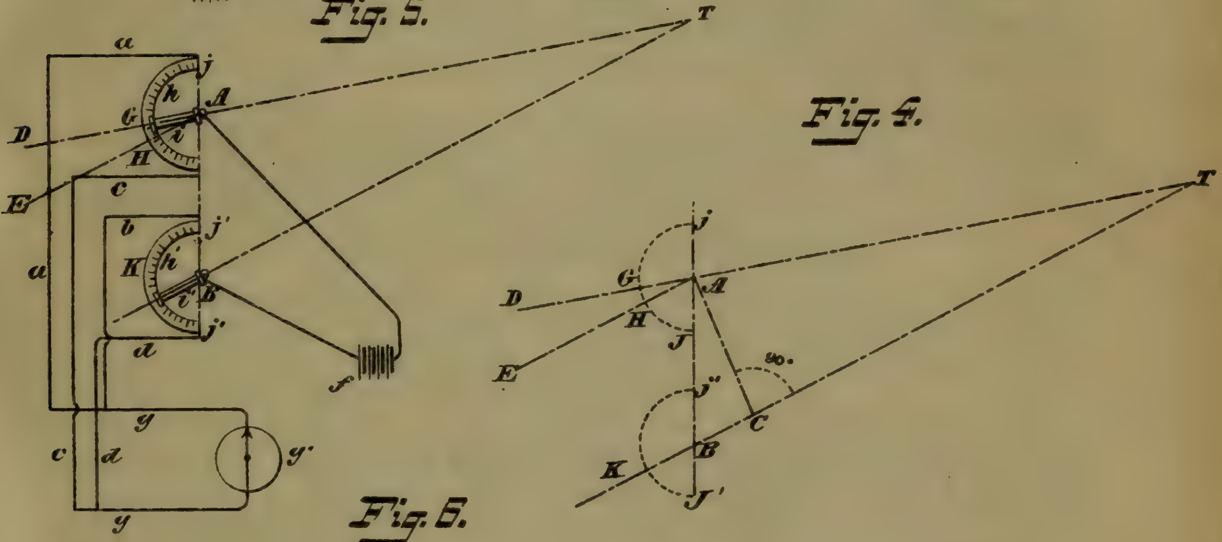
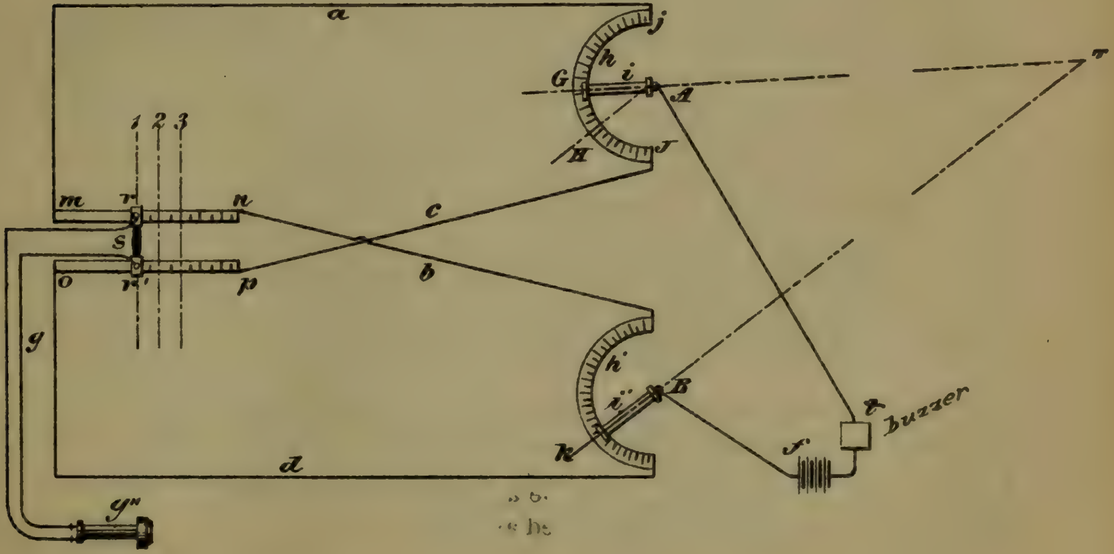


Fig. 6.



end k' with said arc, and to its pivot l' is connected the member d. The arrangement and construction of arc h' and arm i' are similar to that of arc h and arm i. Consequently when the arm i is set at a certain point on the arc h the arm i' must be set at the corresponding point on the arc h', in order that the resistance of the lengths of the arcs h h', respectively, between the point k and point h and point k' and point h' may balance; hence if the arm k be set at a certain angle the observer at arm k may recognize that angle by noting the position of the arm k and the galvanometer, as before. It will be observed, however, that the effect of moving the arm i over arc h is practically to lengthen or shorten or to interpose more or less resistance in the member a of the bridge, and by operating the arm i' a like effect is produced in the member b. The resistances or lengths of the members c and d remain unchanged.

Referring now to Fig. 3, there is shown an arrangement which forms the basis of the specific embodiment of the invention, more particularly hereinafter described. In said Fig. 3 the arc h is connected at its respective ends j J to the members a c, and the arc h' is similarly connected at j' J$'$ to the members b d. The battery-wires connect to the pivots l l' of the arms i i', as before. Now when the arm i is moved from its middle position on its arc toward j less resistance is caused in the member a and more resistance in member c, and when moved in the opposite direction the reverse occurs. So, also, a similar effect is produced by moving arm i', and thus the resistance offered by all four members of the bridge may be affected instead of that due to only two of them, and differential results may be obtained, as will more fully be apparent in the following description of a device for measuring distances, such as a range-finder for guns.

Referring to Fig. 4, let T be the position of the object the distance of which from the point A it is desired to ascertain. Let AB be any short base-line. Draw AC at right angles to BT, EA parallel to BT, and prolong AT as to D. By trigonometry

$$\left.\begin{array}{l}\mathrm{AC}=\mathrm{AT}\sin\mathrm{ATC}\\ \mathrm{AT}=\mathrm{AC}\operatorname{cosec}\mathrm{ATC}\end{array}\right\}\text{and}\left\{\begin{array}{l}\mathrm{AC}=\mathrm{AB}\sin\mathrm{ABC},\text{ whence}\\ \mathrm{AT}=\mathrm{AB}\sin\mathrm{ABC}\operatorname{cosec}\mathrm{ATC}.\end{array}\right.$$

AB, being the measured base-line, is known, and the angle ABC at the point of observation is easily determined, so that the angle ATC remains to be found; but ATC= DAE, and DAE is subtended and measured by the arc GH. Arc GH=arc jH—arc jG, and arc jH=arc J$'$K; hence arc GH=arc j'K—arc jG.

In Fig. 5 the diagrams Figs. 3 and 4 are combined, i i', as before, being swinging arms traversing the arcs h h', and the connections a b c d of the bridge being present also, as before. Let the arms i and i' represent alidade-arms or telescopes, both directed upon the object T. The arcs jG and j'K not being equal, the bridge will not balance; but when the telescope, i, is moved to the line EH then the bridge will balance; but the distance thus moved is the arc GH, the length of which may be read off from the arc h itself. It will be seen, therefore, that the operation of determining the distance AT becomes, by the aid of this apparatus, exceedingly simple. The observers at the respective telescopes i and i' direct their lines of sight upon the object. The observer at i notes the angle jAG or length of arc jG. He then moves the telescope i until the galvanometer g', which may be placed conveniently near his position, shows no deflection, and notes the angle jAH, or length of arc jH. The difference between the arcs jG and jH equals the arc GH, whence the angle ATB, and hence the distance AT, is found by the observer at the arm i, or, in other words, by an observer at the base-line. The disposition of the apparatus whereby an observer at a point distant from said base-line may at once read off the distance AT from a suitable scale will now be explained.

Referring to Fig. 6, the members a and b of the bridge are connected to opposite extremities of a bar m n of conducting material, and the members c d are connected to the extremities of a similar and parallel bar o p. Adjustable upon said bars o p and m n is a slider r r', having a middle portion s of insulating material, so that the current from bar m n, for example, does not pass across said slider r r' to bar o p, but proceeds by the wire *g* through the telephone *g''*, which here takes the place of the galvanometer *g'* in the preceding figures. Interposed in the battery-wire, as at *t*, is any form of automatic circuit-breaker or "buzzer," the object of which is to produce an audible sound in the telephone *g''*. Suppose, now, that the telescopes *i* and *i'* are sighted upon the distant object T, as before, and the slider *r* is at the middle point 1 of the parallel bars *m n* and *o p*. The resistances in the bridge will obviously not balance, and the sound of the buzzer will be heard in the telephone *g''*. It has already been explained in connection with Fig. 5 how, by moving telescope *i* to the point H, the resistances might be balanced, and if that were done, with the arrangement shown in Fig. 6, the fact would obviously be indicated by a cessation of sound from the telephone; but, now, let it be assumed that the telescope *i*, after being sighted upon the object T, is not moved, or, in other words, that the observers, respectively, at the two telescopes *i* and *i'* simply adjust their instruments in line with T. Obviously, then, the distance of the bridge from *r* to G (member *a*) is less than the distance from *r* to *k* (member *b*) by the length of the arc GH. Similarly the distance on the bridge from *r'* to G (member *c*) is greater than the distance from *r'* to *k* (member *d*) by the length of arc GH.

Now let the resistance per unit length of the bars *m n o p* be made equal to or with some definite relation to the resistance per unit length of the arcs *h h'* and lay off on bar *m n* a distance *r* 3 and on bar *o p* a distance *r'* 3, said distances being such that the resistance due thereto will be equal to that of the arc GH. Clearly, if the end *r* of the slider be moved to the position 2 on bar *m n*, the member *a* will be increased and the member *b* will be diminished by the distance *r* 2, which offers a resistance equal to one-half that of arc GH, and if the end *r'* of the slider be moved to the position 2 on bar *o p* then the member *c* will be decreased and the member *d* increased by the distance *r'* 2, which also has a resistance equal to one-half of arc GH. As both ends of the slider move simultaneously, it follows that when its extremities are adjusted in the position 2 then the bridge will balance and the sound in the telephone will cease. Applying this practically, let the bars *m n o p* be laid off in suitable scale-divisions from *r* to *n* and *i'* to *p*. The two telescopes *i* and *i'* being sighted on the object, the distant observer listens at the telephone *g''* and moves the slider *r r'* along the bars *m n o p* until the sound ceases. The scale marked on the bars then shows an indication corresponding to the length of arc GH, or, if desired, actual distances corresponding to such indications.

As installed on board ship this instrument consists of a pair of electrically connected plane tables, one at each end of a base-line, and upon each one of which is mounted a telescope. For angles between 20° on each bow and quarter an athwart-ship base-line is selected in some place from which a clear view can be obtained. For the remaining angular train a fore and aft base-line is used.

Plate II illustrates the arrangement of the instrument as mounted on the U. S. S. *Baltimore*. In Fig. 1, which shows the forecastle mount, the telescope *a* and the scale *b* are on a slide, *c*, fitted to revolve about a pivot in the middle of the table. The telescope has a vertical movement on trunnions, and the scale is graduated in yards.

The resistance arcs *d* and *d'*, to which the battery current enters at *e* by means of a rolling electrical contact, are set in a groove cut in the insulating material which forms the upper part of the rim of the table. *f* and *f'* are compensating wires leading from opposite ends of the resistance arc *d'* to opposite ends respectively of the bridge bars *g* and *g'*. The other ends of the bridge bars are connected with the after plane table by the leading-wires *h h*.

PLATE II.

The Fiske Range Finder.

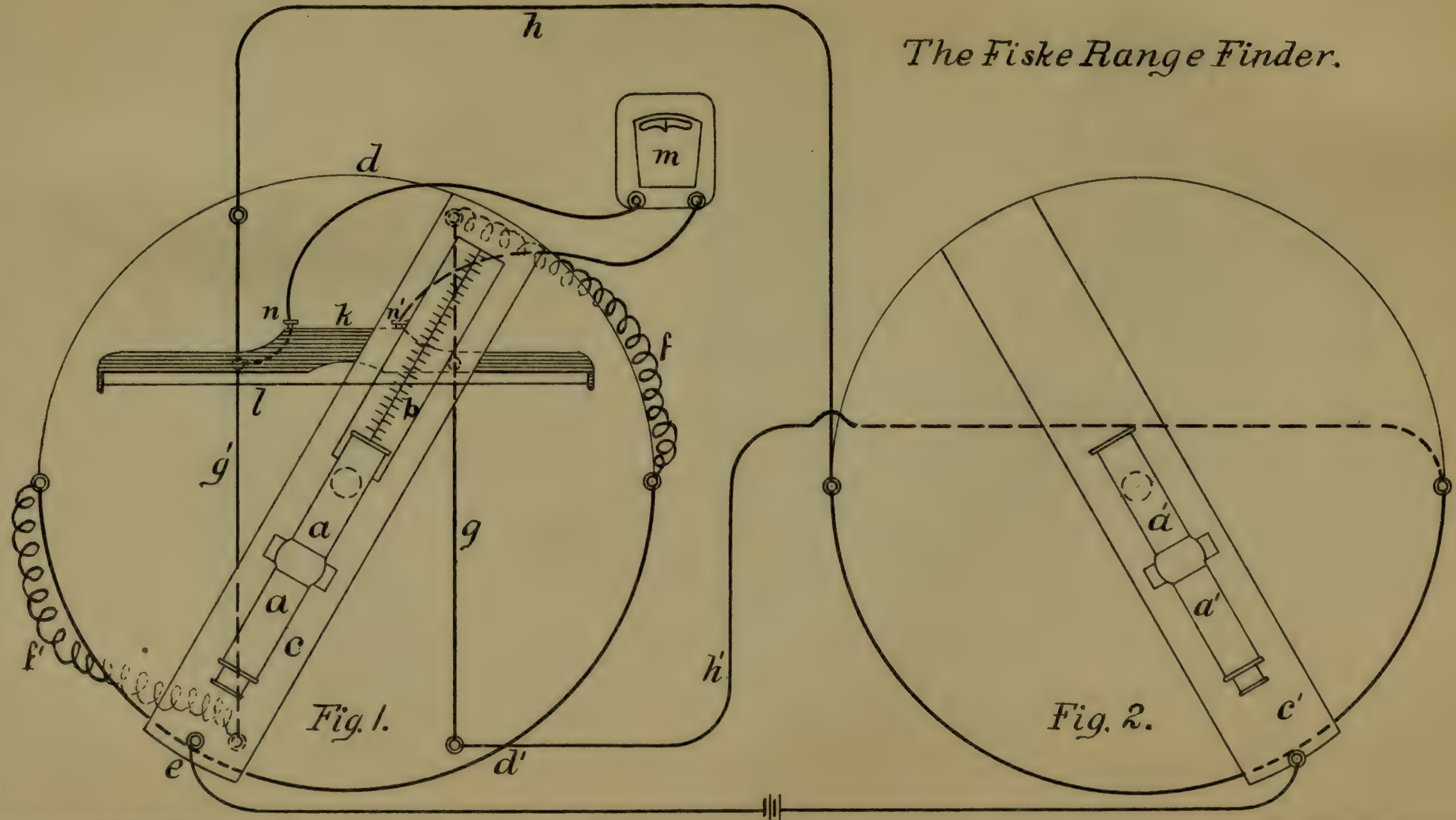
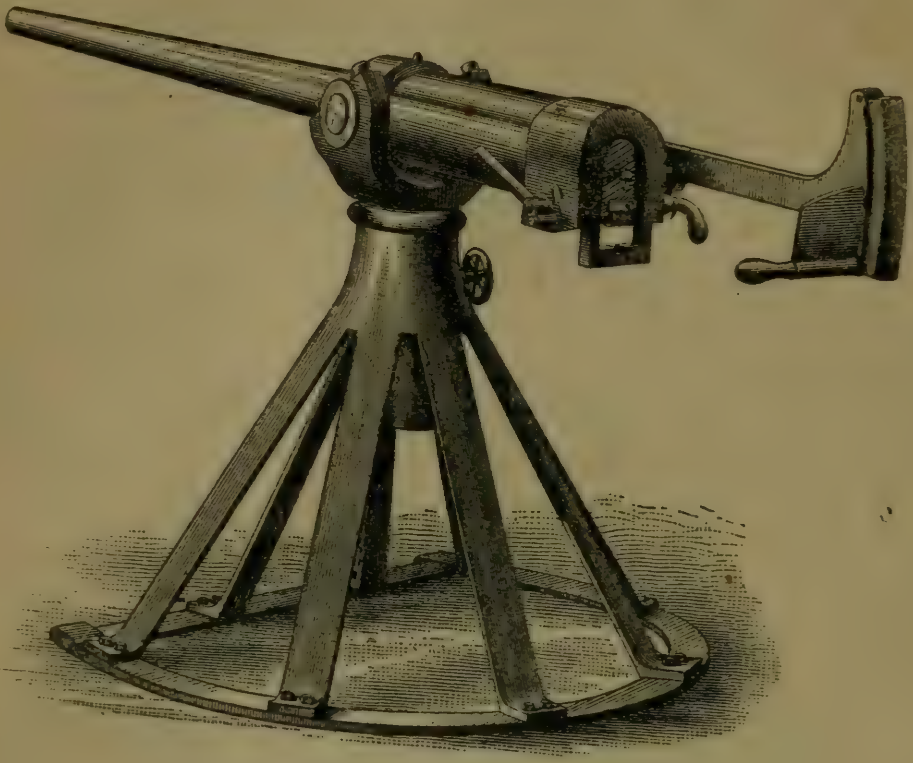
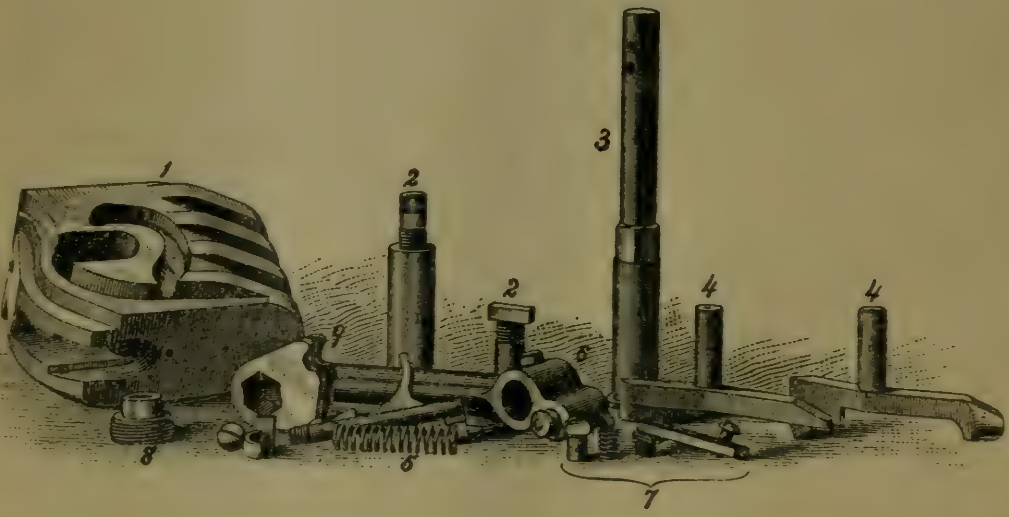


Fig. 1.

Fig. 2.

Driggs-Schroeder R.F. Gun.





In the latest form of the Fiske Range-Finder, the apparatus has been much simplified and has been made direct reading. Two indicators, which are substantially dead-beat galvanometers, permanently secured on the bridge and in the conning tower respectively, are graduated in yards; and the act of directing the telescopes at the object, causes both indicators to show the distance of that object, no matter what is its direction from the ship. This is the apparatus at present on board the *Baltimore.*

K is the slider, which carries above it an index-wire, *l*, and which moves on projecting guides which keep it constantly parallel to the base-line.

The galvanometer *m* is connected with the contact-springs *n n* on the slider by flexible conducting-wires long enough to permit of moving the galvanometer to any part of the table.

Fig. 2 shows the arrangement of the after table, which is only used for observing with the telescope *a′*.

To use this instrument an observer at each plane table brings the target to the intersection of the cross-wires of his telescope. At the same time a third person moves the slider until the galvanometer shows *o*, at which instant the index-wire will cross, on the graduated scale, the figures showing the required distance.

This instrument was tested by a Board of naval officers on the U. S. S. *Chicago* with the following results:

Base line.	True distance of object sighted upon.	Mean error of four sights on each object.	Base line.	True distance of object sighted upon.	Mean error of four sights on each object.
	Yards.	*Yards.*		*Yards.*	*Yards.*
Fore and aft line, 292 feet..	1,560	9.	Fore and aft line, 292 feet.	1,070	3.5
Do................	940	4.5	Do	570	5.75
Do................	1,000	5.75	Athwartships, 44 feet...	1,300	15.
Do................	1,060	4.5	Do................	1,070	40.

	Per cent.
Mean error with long base line..	0.6
Mean error with short base line	1.9

No difficulty was found in making the observations or in reading off the distances without delay.

The Board found that after one trial it was easy to follow a ferry-boat from wharf to wharf and to know its distance away at any instant.

RAPID-FIRE GUNS.

The employment of these guns for naval use has become general, and several new types have appeared during the past year.

The highest velocity yet attained by any gun of this system is 2887 f. s., which is at the rate of 1,968 miles an hour.

ARMSTRONG 6-INCH RAPID-FIRE GUN.

This gun is similar in general design to the 4.724-inch rapid-fire gun described in Nos. VI and VII.

The combined weight of the powder charge, projectile, and metallic cartridge case for this gun was found to be too great for one man to handle, in consequence of which the powder has been put up in a sealed metallic cartridge case, and is handled separately from the projectile.

These guns now constitute the main battery of the Italian cruiser *Piemonte*, and are to be adopted for use in the English navy.

The principal details and the results of trials on the proving ground are as follows:

Weight of gun	5.5 tons.
Length of bore	40 calibres.
Weight of charge	38 pounds.
Kind of powder used	Chilworth special.
Weight of projectile	100 pounds.
Muzzle velocity	2,339 foot-seconds.
Muzzle energy	3,797 foot-tons.
Energy per ton of gun	690.
Calculated penetration in steel at muzzle	12.8 inches.
Rate of fire per minute (unaimed)	6.

In these trials the gun was mounted on a stable platform, and no effort was made to secure accuracy of aim. Taking into consideration the weights of charge and projectile and all the disadvantages attending firing on board ship, we do not believe that, in use afloat, this gun will give an average of over three aimed shots per minute.

CANET RAPID-FIRE GUNS.

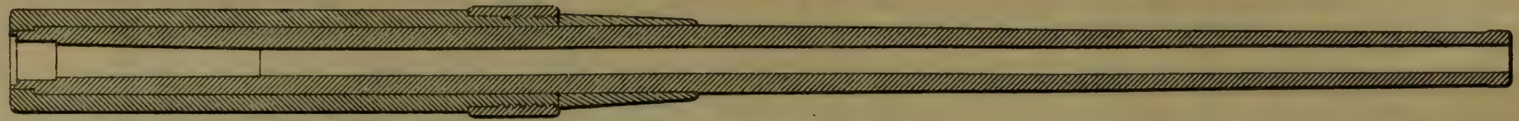
The guns of this type are constructed of steel and consist of a tube reinforced by a long jacket and a single hoop. Fig. 1, Plate 1. The tube is rigidly clasped by the jacket, the rear end of which takes in a mortise in the rear end of the tube. A conical hoop clasps the chase forward of the jacket. The trunnion band has a screw thread on a part of its interior and is screwed on to the forward end of the jacket, which is reduced in diameter at that part.

The steel used in construction must come up to the following requirements:

Minimum limit of elasticity	lbs. to sq. inch	45,514
Tensile limit	do	85,338
Elongation	per cent	14

The breech mechanism is the invention of M. Canet and is peculiar to these guns. The following description will be understood by reference to Plate I:

The breech plug is an interrupted screw of four equal sectors carried by a bronze face-plate, A, Fig. 2, from which extends a bracket, B, in which is cut a longitudinal groove, *b*, Fig. 3. This bracket is fitted with an automatic safety-latch. The rear face of this breech-plug is recessed in the form of a circular cavity, from the lower part of which three beveled teeth, *a*, *a*, *a*, project, and is extended by a shaft, C, Fig. 4, which engages in a bronze socket supported by the pivot *c*. This pivot also supports: first, a portion of a pinion, D, Fig. 4, which is fitted to gear into the above-mentioned beveled teeth; second, a guide, *e*, CANET 15 c/m R.F. GUN.



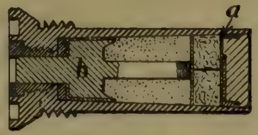


FIG. 5

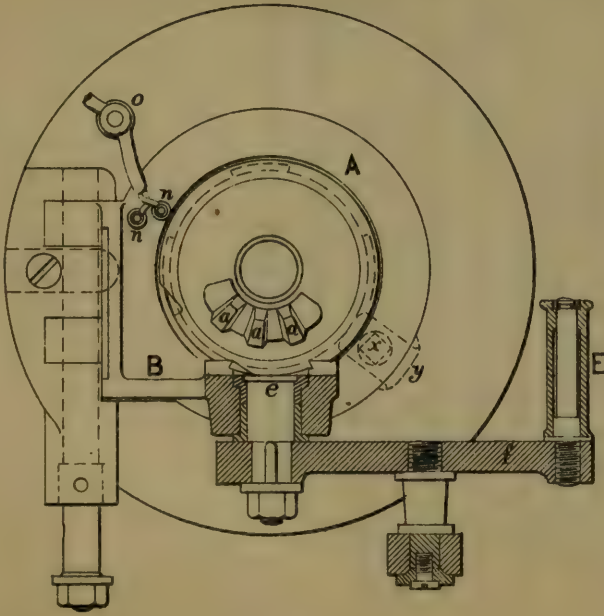


FIG. 2

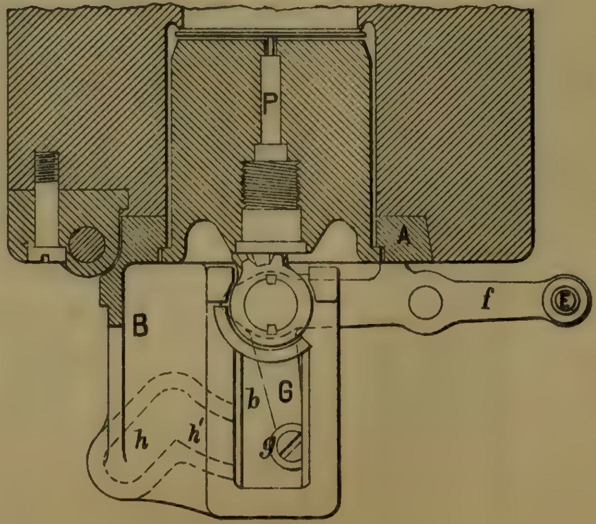


FIG. 3

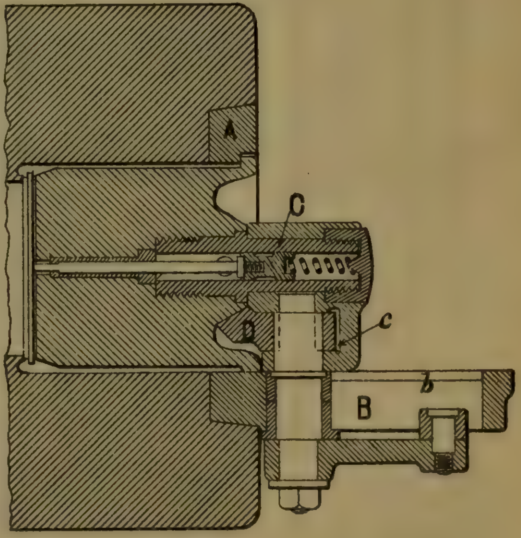


FIG. 4

Fig. 2, which slides in the groove, *b*, Fig. 4; third, a double lever, the longer arm, *f*, Fig. 3, terminating in the handle, E, and the smaller, G, having a roller, *g*, moving in a horizontal groove, *h*, *h′*, under the bracket B. This groove is of peculiar form, one part, *h′*, being an arc of a circle having the pivot *c* as a centre, and the other, *h*, at an angle to the axis of the piece.

To open the breech.—Pull the handle E quickly from right to left. The pinion D acts on the beveled teeth *a*, *a*, *a*, and revolves the breech plug one-eighth of a turn, the roller *g* at the same time traveling in the groove *h′*. When this roller strikes the straight side of the groove *h* the extra effort exerted on the handle E frees the catch of the guide *e* and the plug draws back through the face-plate. When the roller reaches the end of its travel the plug and the face-plate turn together around a hinged bolt and swing to one side clear of the breech. A return movement of the handle will close the breech.

The extracting device acts automatically. It consists of two extractors held by springs recessed one on each side of the breech-plug, with the ends projecting in such a manner that when the plug is forced home they close over the rim of the cartridge-case ready to withdraw it when the breech is opened.

Electric firing mechanism.—On the rim of the face-plate are two binding screws, *n n*, Fig. 2, to which the firing-wires are attached. One of these, for the return wire, is simply screwed into the metal; the other is insulated and, when the breech is in the locking position, and only then, communicates with a spring-button which projects into the interior and makes connection with an insulated plate on the firing-pin perpendicular to the axis of the pin. The firing-pin P, Fig. 3, is insulated by rings of ebonite and is pressed against the insulated plug *b*, Fig. 5, of the fuze by a spiral spring.

In the electric fuze, Fig. 5, which is screwed into the base of the cartridge-case, a platinum thread, *a*, connects the fuze composition with the insulated plug *b*, this plug also acting as an obturator for the fuze.

When the breech-plug is pushed in the firing-pin takes against the plug *b*, Fig. 5, and when the one-eighth of a turn is taken, which completely closes the breech, the insulated binding screw makes connection and the current can be sent to the fuze at the will of the gun captain.

Only three calibres of these guns are to be constructed, each of which is to be in two lengths—36 calibres and 48 calibres.

The principal features of these guns are herewith tabulated.

Details.	10 centimetres.		12 centimetres.		15 centimetres.	
	36 cal.	48 cal.	36 cal.	48 cal.	36 cal.	48 cal.
Calibre .... inches..	3.94	3.94	4.72	4.72	5.91	5.91
Weight of gun .... tons..	1.3	2.1	2.3	3.2	4.3	6.2
Weight of carriage .... do....	1.7	1.9	2.5	2.9	4.0	4.5
Rifling { No. of grooves	....	30	....	36	....	40
Rifling { Twist	....	0–5° 08′	....	0–5° 07′	....	0–5° 07′
Weight of charge .... pounds..	9.7	14.3	17.6	23.1	28.7	44.1
Weight of projectile .... do....	28.7	28.7	46.3	46.3	88.2	88.2
Weight of cartridge case .... do....	....	....	....	....	....	27.3
Weight of breech block and tray.do ...	....	74.96	....	125.66	....	134.48
Maximum recoil .... inches..	....	11.8	....	15.8	....	21.7
Muzzle velocity .... f.s..	2,100	2,493	2,100	2,493	2,100	2,493
Calculated penetration in steel at muzzle .... inches..	7.1	9.0	8.2	10.5	10.2	13.1

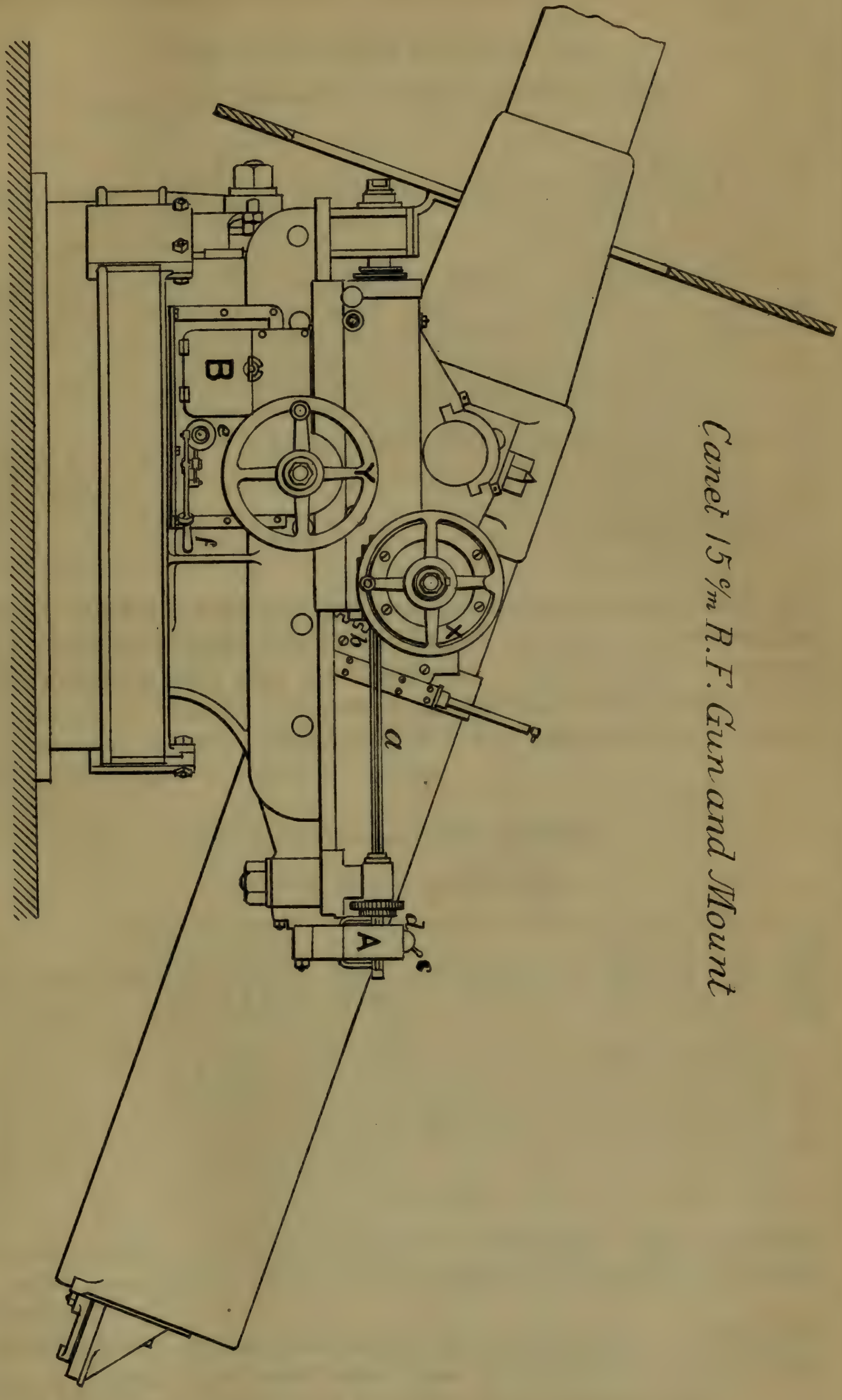
The actual velocities obtained from the 48-calibre guns of 10 centimetres and 15 centimetres were in excess of the calculated velocities given in this table.

All these guns are to be mounted for short recoil and automatic return to firing position.

The 10 centimetre and 12 centimetre guns are to be mounted on oscillating carriages, which are arranged to so work as to cause a projecting arm, when the gun is returning to battery after the completion of the recoil, to act on one arm of the lever in such a manner as to cause the automatic opening of the breech. The breech is always to be closed by hand.

The pointing of the 15-centimetre gun can be effected either by means of wheels and gearing by hand or by means of electric motors, at the will of the gun captain. In the latter case two motors are used, one in the box A, Plate II, which causes the shaft, *a*, to rotate and give movement to the elevating gear, and the other in the box B, which gives movement to a horizontal pinion turning around the axis *e*. These motors are actuated by the hemispherical cover *d*, and the lever *c*, and can only be used separately. The lever *f* is used to engage *e* with either the handwheel or the electric motor. To point the gun when using the motors, the gun captain turns the cover *d* to the right or left for lateral train, and then gives elevation or depression by moving the handle *c* vertically.

PLATE II.



Canet 15 c/m R.F. Gun and Mount

The following tables give the results of the only trials with these guns which have been reported up to the present time.

CANET 10-CENTIMETRE RAPID FIRE GUN.

Results of trials made between July, 1889, *and February,* 1890.

Kind of powder used.	Weight of charge.	Weight of projectile.	Initial velocity.	Chamber pressure.	Kind of powder used.	Weight of charge.	Weight of projectile.	Initial velocity.	Chamber pressure.
	Lbs.	*Lbs.*	*f. s.*	*Tons.*		*Lbs.*	*Lbs.*	*f. s.*	*Tons.*
C_2 special	8.8	28.7	1,853	13.3	BN. Sample A	8.4	28.7	2,562	15.9
Do	11.0	28.7	2,093	20.0	Do	8.6	28.7	2,628	16.8
PB_3 S special	11.0	28.7	2,217	7.6	BN. Sample B	7.9	28.7	2,490	17.7
Do	15.4	28.7	2,329	16.5	Do	8.2	28.7	2,555	18.0
Do	16.5	28.7	2,404	18.4	Do	8.4	28.7	2,572	19.6
Do	16.5	28.7	2,378	16.5	Do	8.2	28.7	2,559	18.0
Do	17.3	28.7	2,427	19.7	BN. Sample C	7.9	28.7	2,237	11.7
BN. Sample A	5.3	28.7	1,850	6.3	Do	8.8	28.7	2,355	13.5
Do	6.2	28.7	2,011	8.3	Do	9.5	28.7	2,536	16.6
Do	7.0	28.7	2,247	10.2	Do	9.9	28.7	2,614	18.1
Do	7.7	28.7	2,437	14.2	Do	9.9	28.7	2,614	18.0

The C_2 and PB_3S were specially prepared brown powders. The BN was a smokeless powder which is surmised to be similar in composition to the Poudre B used with the Lebel rifle. Three samples of it were used, sample B evidently being much quicker than the two others.

The highest velocity obtained, 2,628 f. s., corresponds to a muzzle penetration in steel of nearly 9.8 inches.

CANET 15-CENTIMETRE RAPID FIRE GUN.

Results of trials in March, 1890.

Kind of powder used.	Weight of charge.	Weight of projectile.	Initial velocity.	Chamber pressure, tons to sq in.	Kind of powder used.	Weight of charge.	Weight of projectile.	Initial velocity.	Chamber pressure, tons to sq in.
	Lbs.	*Lbs.*	*f. s.*			*Lbs.*	*Lbs.*	*f. s.*	
BN. No. 19	17.6	88.9	1,666	4.1	BN. No. 19	32.0	88.6	2,673	16.8
Do	22.1	88.9	1,962	6.3	Do	32.0	88.6	2,670	17.3
Do	26.5	88.6	2,303	11.8	Do	33.1	88.9	2,749	18.4
Do	28.7	89.3	2,427	13.7	Do	33.1	88.9	2,746	18.5
Do	30.9	88.9	2,601	16.7					

The maximum recoil only amounted to 20.9 inches. The charge and projectile were in one. Two men were required to handle the complete cartridge.

These accounts of the trials of the 10 centimetre and 15 centimetre Canet R. F. guns have been taken from the published reports of the Société Anonyme des Forges et Chantiers de la Méditerranée.

During further trials of this 15 centimetre gun in May of this year, a more powerful smokeless powder was employed which developed an initial velocity of 2,887 f. s., with a safe chamber pressure. The energy developed was equivalent to 1,027 f. t. per ton of gun. Such a result as this has never before been obtained from any gun.

A number of these Canet rapid-fire guns have already been ordered for the Chilian navy.

DAUDETEAU-DARMANCIER RAPID-FIRE GUN.

A system of breech closure, known by the name of its inventors, Messrs. Daudeteau and Darmancier, has been applied to rapid-fire guns constructed in France by the Forges de St. Chamond, and is illustrated in the accompanying plate.

The breech-plug, Fig. 2, is an interrupted screw of three equal sectors, and is entered and withdrawn from the breech of the gun by a single rectilinear movement of the handle *a*.

On each side of the face of the breech is a circular groove, *b*, in which slides a hollow bronze bracket, *c*, in the lower part of which is contained the firing mechanism, and upon which moves the circular slide *d* at the end of which is the handle *a*, while the front is formed into a ring through which the end of the breech-block passes, being held by the recess *f*. It has two spiral grooves, *g*, cut through it in which work two symmetrical studs forming part of the ring. By means of these studs the breech-block is caused to turn for either engaging or disengaging the screw-threads by simply moving the slide *d* in or out.

To open the breech.—Draw the handle *a* to the rear and the studs will slide in the spiral grooves and cause the breech-plug to make one-sixth of a turn and release its screw-threads from those of the breech. Then the ring will draw a projection of the block into the recess *f*, and the block to the position shown in Fig. 2.

In this movement the block compresses two hooks carried by the spring-pins of the lug *h*, this lug fitting into the recess *h′* and sustaining the bracket. When this movement is completed, and the lug *h* has become disengaged from its recess *h′*, the bracket slides down in the circular grooves *b* by its own weight, and takes the position shown in Fig. 3. In the movement to the rear the hammer becomes cocked.

To close the breech.—Raise the breech mechanism by the handle *a* and push the plug in smartly until the cam *i*, Fig. 3, comes in contact with the face of the breech. At the end of this movement the studs will work in their grooves and cause the plug to make one-sixth of a turn and engage its screw-threads with those of the breech. The gun can be fired in this position by pulling the trigger.

To fire automatically, move the key *l* to the position *l′*, which will give to the circular bolt an additional advance forward and permit the heel-rod *m*, Fig. 2, to take against the trigger lever *n*.

Firing cannot take place until this position is attained, which does

Daudeteau-Darmancier 47m/m R.F. Gun.

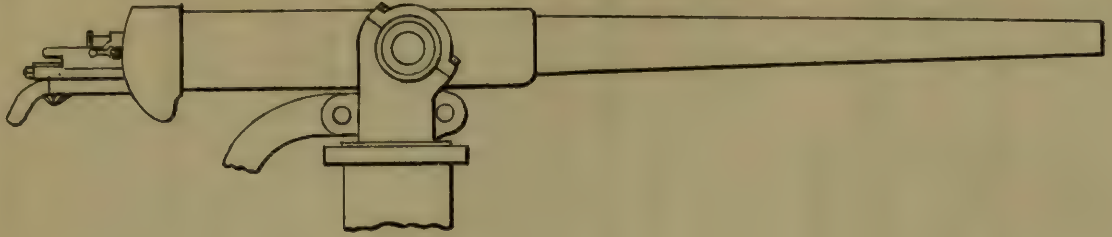


Fig. 1

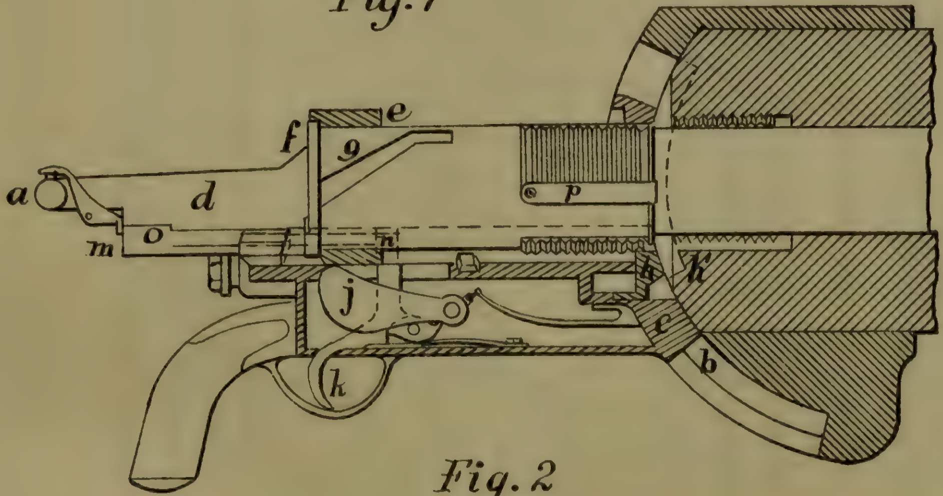


Fig. 2

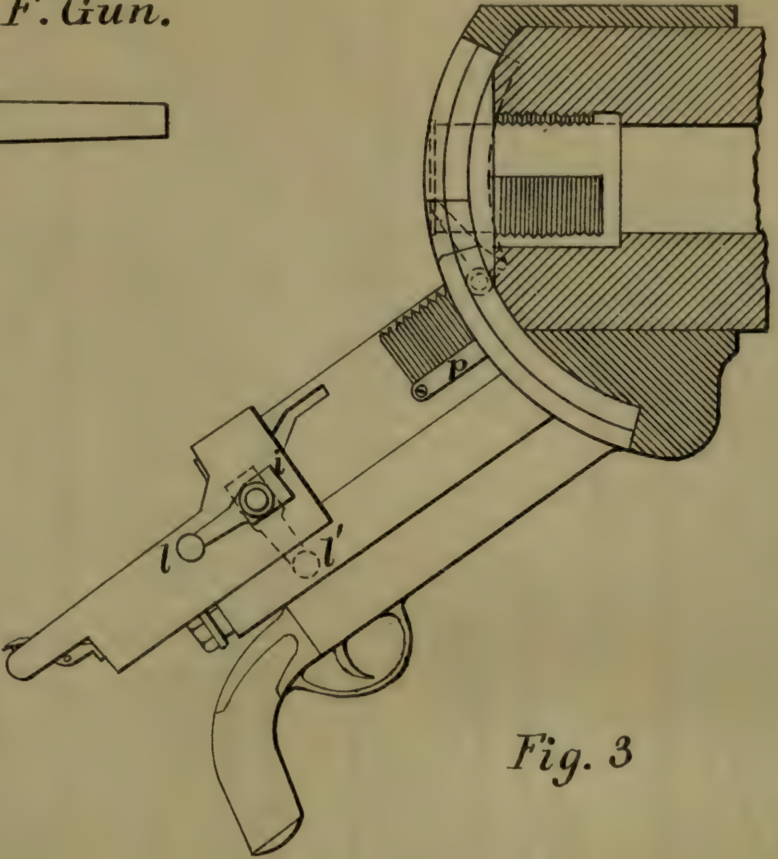


Fig. 3

not occur until the breech is completely closed, when the trigger-lever *n* is raised in line with the channel *o* for the heel-rod *m*. As the firing-pin is in the axis of the breech-plug it cannot be struck until the plug has made its one-sixth of a turn, in which position the breech is completely closed.

The extraction of the empty cartridge case is effected by two independent extractors, P, one on each side of the plug.

A gun on this system was exhibited at the Paris Exposition of last year, the principal details of which are as follows:

Calibre of gun	inches..	1.85
Length of bore	calibres..	45
Total length of gun	inches..	96.45
Weight of gun	pounds..	507.15
Weight of projectile	pounds..	3.29
Weight of charge	ounces..	27.3
Total weight of cartridge	pounds..	6.3
Inclination of rifling		0° 30′—7°
Number of grooves		20
Initial velocity (estimated)		2034

It is reported that calibres of 2.24 inches, 3.94 inches, 4.72 inches, and 6.1 inches are to be constructed by this company.

As compared with other types of rapid-fire guns the work required to raise the breech-block in this one would, it seems to us, be very much increased.

DRIGGS-SCHRŒDER RAPID-FIRE GUNS.

The United States Navy Department has ordered twenty guns of this type; ten 3-pounders and ten 6-pounders.

The United States War Department has ordered one 6-pounder, and has acquired the right to manufacture a gun of this type of 3.2-inch calibre.

The English military authorities have purchased one 3-pounder.

The patent rights for all Europe have been sold to a foreign firm.

The accompanying plate contains illustrations of this gun and of all the different parts of the breech mechanism. These latter are numbered as follows:

1. Breech-block.
2. Guide-bolts.
3. Main bolt.
4. Extractors.
5. Firing-pin and spring.
6. Operating handle.
7. Sear-bolt spring and cap for holding spring in place.
8. Screws for holding face-plate in place.
9. Operating cam.

For a full description of this type and its breech mechanism see page 361, No. VII.

ENGSTRÖM RAPID-FIRE GUN.

This gun, the breech mechanism of which was invented by Lieutenant Engström of the Swedish navy, is noticeable for its extreme lightness and for the peculiar form of breech mechanism employed. The system is now in use in the navies of Sweden and Norway.

The opening and closing of the breech is effected by a to and fro curved movement of a lever, D, Fig. 3.

This lever moves a bolt, A, which revolves about an axis, C, passing horizontally through two symmetrically placed ears on the upper end of the breech. On this same axis is also mounted a sector, F.

On a similar horizontal axis, C′, on the lower part of the breech, are mounted a sector, G, and the breech-block B.

On the plate F are two cylindrical tenons *f f*,′ and on the sector G, two corresponding mortises, *g g*.′ At the end of the lever D is a handle, E.

For simplicity of description we have shown this gun with the breech open, ready for loading.

To close the breech.—Draw back the lever D by means of the handle E. The sector F will move forward about the axis C, and its tenon, *f*′, taking in the mortise *g*, will force the sector G upward about the axis C′, and the breech-block B will be drawn up and around with it. As soon as the two sectors arrive in line with each other the tenon *f*′ will commence to leave the mortise *g*, but, in the mean time, the tenon *f* will have taken in the mortise *g*′, and the revolution of the sector G will continue until the breech-block has taken against its seat.

The opening of the breech is effected by simply raising the lever D, when the above-mentioned operations will be reversed.

The breech closure is made complete by means of a spring plate, K, fitted to revolve around an axis, P, at the end of which is a nose, *l*, which, when the breech is closed, catches in the mortise *l*′ in the breech-block. When so caught the breech is locked and can not be opened until the nose *l* is cleared of the mortise *l*′ by pressing down on the spring plate K.

The firing mechanism is all contained in the breech-block. H is the firing-bolt, which, when released from full cock, is pressed forward by the mainspring J. It is arranged to be fired either by simply pressing the trigger I, or automatically by means of a movement of the bolt R.

At the end of the trigger I is a projecting nose M, which, in closing the breech, revolves about the circumference of the right-hand lower ear of the piece, keeping the nose raised until it reaches the mortise O, cut in the ear, into which it slips. Then the breech is completely closed, and then only can the gun be fired.

There are two independent extractors, and the gun is fitted with a shoulder-piece.

Only two clasess of this gun have been constructed as yet—a heavy 57-millimetre gun for naval use and a light 57-millimetre gun for field use. The following are the principal details of these guns, as now made in France by the Société Anonyme des Anciens Établissements Cail:

ENGSTROM 57 m/m R. F. GUN.

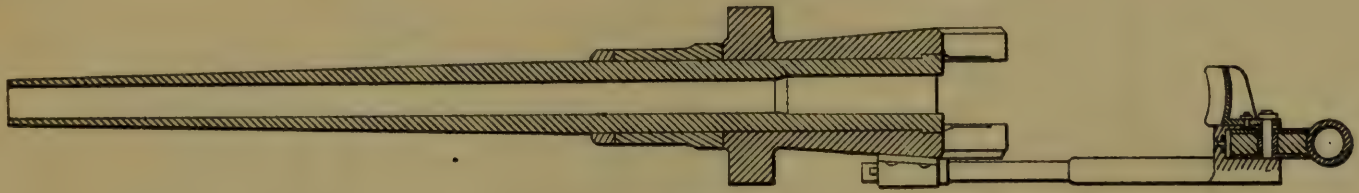


FIG. 1

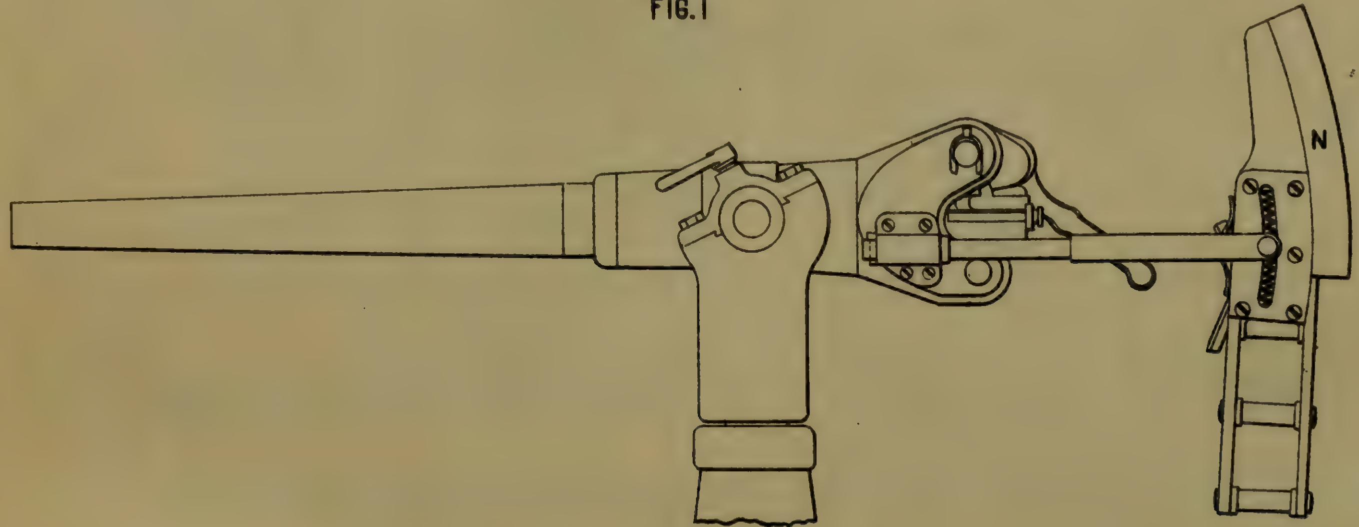


FIG. 2

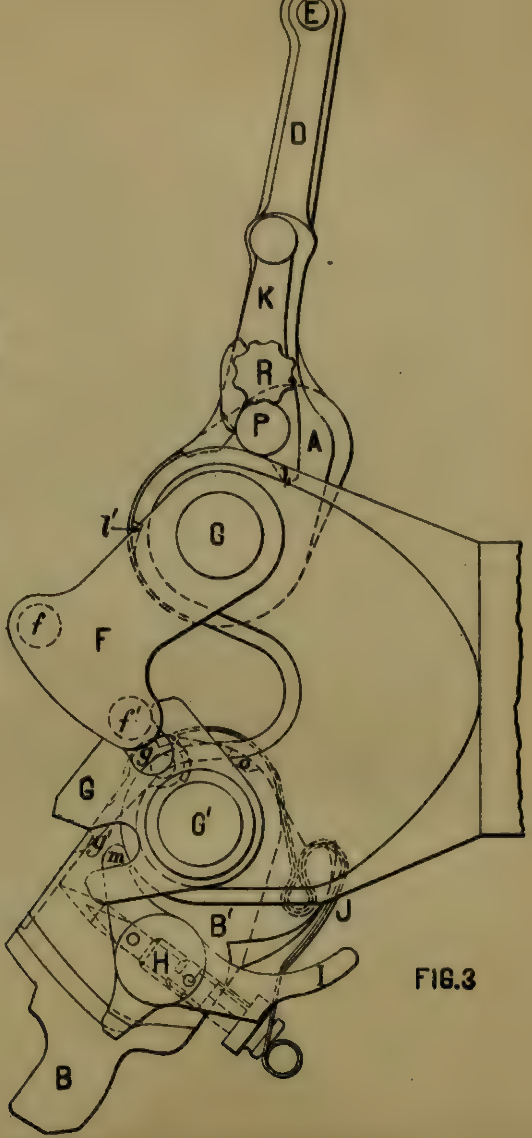


FIG. 3

HOTCHKISS 33 PDR R. F. GUN MOUNT.

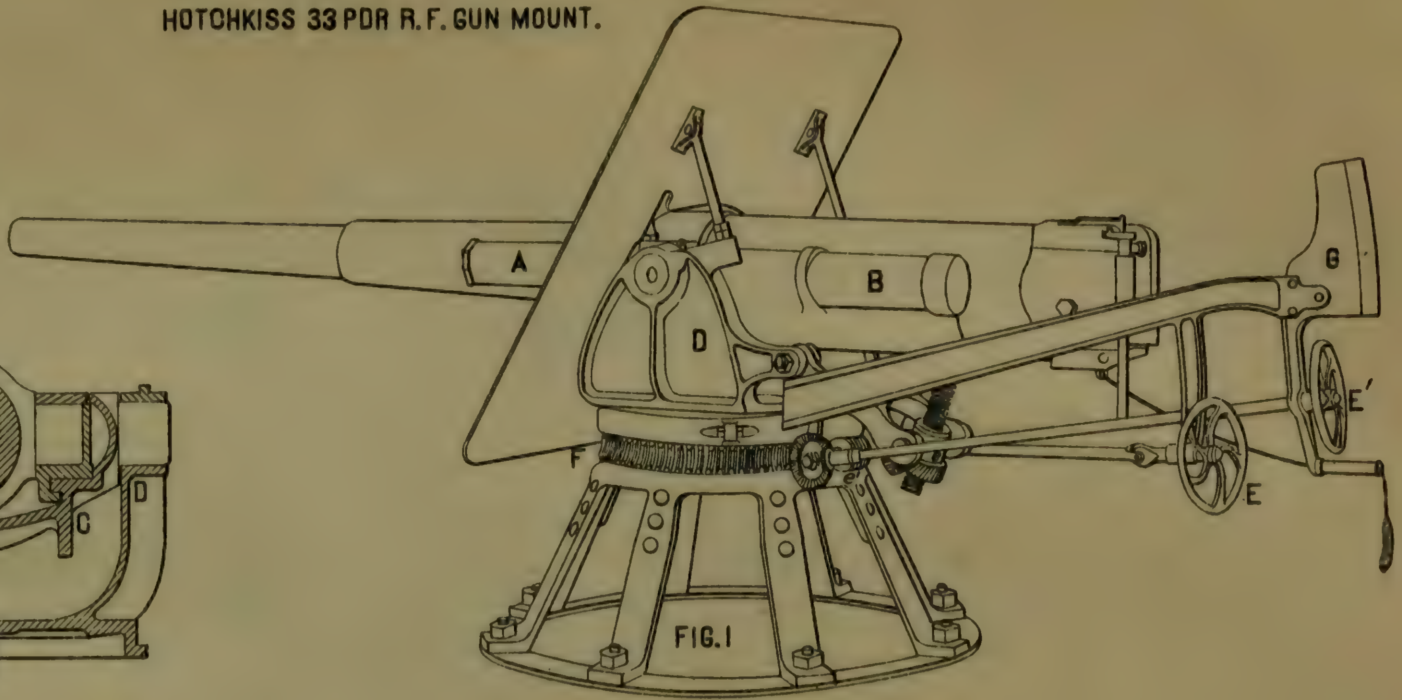


FIG. 1

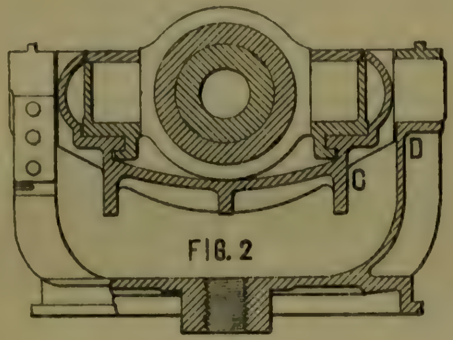


FIG. 2

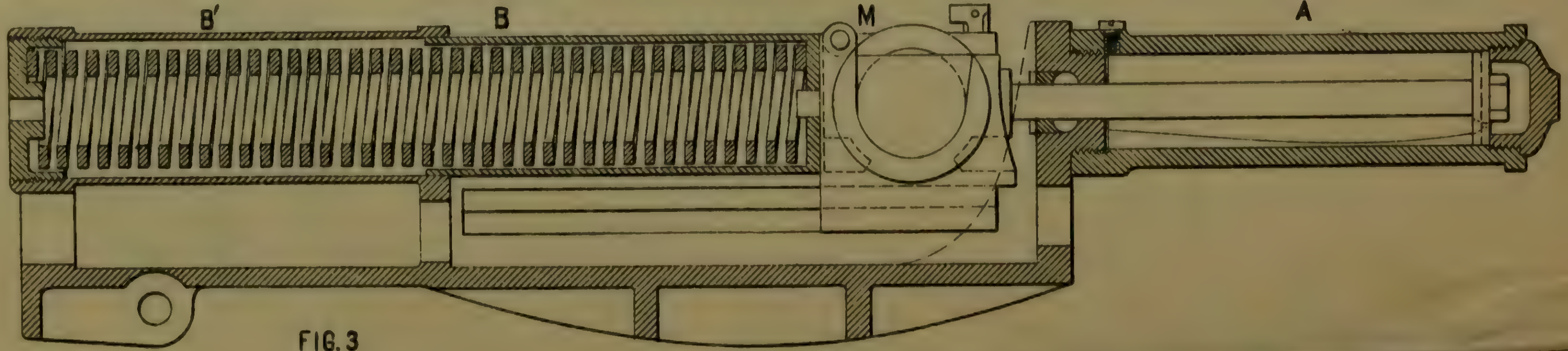


FIG. 3

Details of Engström rapid-fire guns.		57-millimetres (heavy).	57-millimetres (light).
Calibre	inches	2.24	2.24
Total length	do	89.56	58.85
Do	calibres	40	26
Number of grooves		24	24
Total weight	pounds	660	440
Weight of projectile	do	6.05	6.05
Weight of charge	do	1.98	1.32
Initial velocity	f. s.	2,26[illegible]	1,772
Muzzle energy	f. t.	216.3	132.5
Muzzle penetration in wrought iron	inches	5.8	4.5

It is stated that the breech mechanism is easy to work, but it seems quite cumbersome as compared with the wedge type.

HOTCHKISS RAPID-FIRE GUNS.

The largest calibre of this type now completed is the 10-centimetre (3.94-inch), which, with its Elswick mount, is illustrated in the accompanying plate.

This gun consists of a tube, a rear jacket, a front jacket, a locking-ring, and a trunnion-ring. All parts are made of Creuzot steel, forged, oil-tempered, and annealed after tempering, and which have to comply with the following requirements:

Resistance not less than	pounds per square in.	94,000
Minimum limit of elasticity	do	51,500
Elongation after rupture	per cent.	14

The gun is mounted on a cradle C, Fig. 2, which rests in the trunnion-bearings of a steel pivot D, Figs. 1 and 2, which is mounted on a crinoline stand.

The trunnions of the gun are fitted into trunnion-boxes M, Fig. 3. The recoil energies are absorbed by a pair of hydraulic cylinders A, Fig. 3, one on each side of the gun forward of the trunnions, and connected by a passage underneath to equalize the pressure in each. Their piston-rods are attached to the front faces of the trunnion-boxes. To the rear of each trunnion-box are double telescopic cylinders B, B, Fig. 3, each containing a heavy spring under an initial compression. At the end of the recoil the action of these springs returns the gun to the firing position.

The gun is elevated or depressed by means of the hand-wheel E, which, through its shaft and worm wheel, gives a rotary motion to the nut *e* hinged to the cradle. Lateral train is given by means of the hand-wheel E′, which, through its shaft and gearing, gives motion to a screw *e*′, working in the teeth of a worm-wheel, F, placed around the socket.

The shoulder-piece G is hinged to the pivot, and supports, by means of projecting arms, the shafts of the pointing-gear. It is used as a rest for the gunner while pointing, and will serve for rough pointing by simply raising it a few inches, when the worm will become disengaged and permit the piece to be swung around freely. The momentum of the gun is too great to allow rapid pointing and fine sighting by the shoulder-piece alone.

It will be noticed that the shoulder-piece and the sights of this gun are both on the left side. In using this particular calibre it is intended to have the gun-captain stand to the left of the line of the gun with his right shoulder against the shoulder-piece, thus avoiding any risk of danger to his face from the shoulder-piece as well as giving the loader a clear field.

The following is in addition to the details published on page 360, No. VII:

Length of bore .... calibres..	42
Weight of breech-wedge .... pounds..	132.3
Preponderance .... do....	55
Length of complete cartridge .... inches..	41.8
Weight of complete cartridge .... pounds..	55.8
Maximum recoil .... inches..	8
Rate of unaimed shots per minute	10 to 12
Total weight of mount, not including shield .... tons..	1.5

In a trial at St. Denis on April 29, 1890, the following results were obtained:

Gun.	Kind of powder.	Weight of charge.	Weight of projectile.	Muzzle velocity.	Chamber pressure (tons per square inch).
		Pounds.	*Pounds.*	*f. s.*	
10-centimetre (3.94-inch)	SP.	10.8	33	2,080	15.5
Do	BN.	6.8	33	2,156	15.5
Do	BN.	6.8	28.7	2,295	15.5
Do	BN.	7.1	28.7	2,358	15.7
Do	BN.	7.3	28.7	2,389	14.4

These were the last of forty-nine shots that have been fired from this gun up to the present time. Five consecutive shots have been fired in twenty-nine seconds, using flat-headed projectiles, which take up more time in loading than those which are ogival-headed.

Hotchkiss guns of this calibre have been ordered for use in the French navy.

75 MILLIMETRE (2.95-INCH) HOTCHKISS RAPID-FIRE GUN.

Trials with this gun for velocity and pressure took place at St. Denis in March last, at a target 129.2 feet distant, with the following excellent results:

Kind of powder.	Weight of charge.	Weight of projectile.	Muzzle velocity.	Pressure. (tons per sq. in.)
	Lbs.	*Lbs.*	*f. s.*	
BN	2.42	14	1598	6.5
BN	3.30	14	2034	11.0
BN	3.52	14	2127	12.0
BN	3.74	14	2244	14.0
BN	3.96	14	2340	15.5

The powder used, BN, is surmised to be similar to the smokeless powder used in the Lebel rifle.

The number of rapid-fire guns of this type that have been either delivered by, or ordered from, the Hotchkiss Company up to March 31, 1890, is as follows:

Rapid-fire gun:	
1-pdr	581
2-pdr	137
3-pdr	1,983
6-pdr	620
9-pdr	16
14-pdr	6
33-pdr	1
Total	3,344

From which it appears that the 3-pdr., the ideal anti-torpedo gun, is in great demand.

The following are the principal details of some higher calibres of this type which are either proposed or already completed.

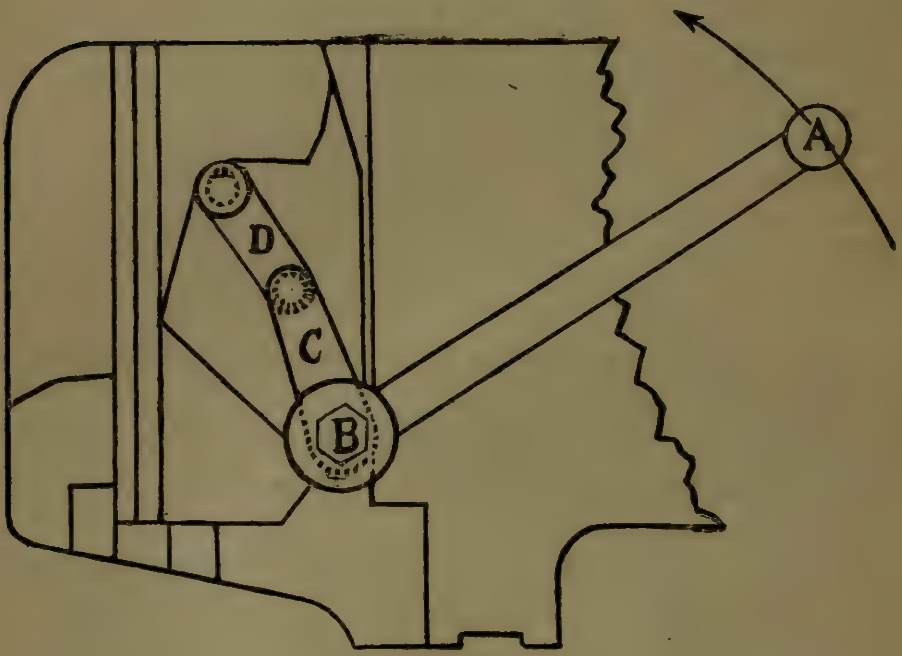
	36-pounder.	55-pounder.	6-inch.
Calibre ... inches	4,724	4,724	6.0
Weight, including breech-block ... pounds	4,730	7,300	12,100
Total length ... inches	182	210	220
Length of bore ... calibres	37	43	36
Weight of charge of ordinary powder ... pounds	17.16	29.7	48.4
Weight of bursting charge ... ounce	16.5–17.1	17.1	49
Weight of projectile ... pounds	36.3–55.0	55	99
Total weight of cartridge ... do	67.32–86.0	99	180
Total length of cartridge ... inches	37–42	52	51
Muzzle velocity, common shell ... f. s.	1788 2288	2132	2000
Penetration in iron plate by steel shell:			
At muzzle ... inches	10.2 11.1	13.4	14.2
At 1,100 yards ... do	7.2 7.9	10.3	11.2
At 2,200 ... do	4.9 6.0	7.9	8.9

SKODA RAPID-FIRE GUN

This gun is named after its inventor, a native of Austria, in which country it has been subjected to several trials during the past year. It is of the usual compound construction, and consists of a tube, a jacket, and a connecting locking band.

The breech block is a falling wedge with its forward face vertical and after face inclined. It contains the working, firing, and ejecting mechanism.

Lack of space prevents a full description of this gun and we will only briefly note its novel features—the method of working the wedge, and the means employed to extract the empty cartridge-case.



To open the breech the lever A is pulled back on the axial bolt B. This causes the lever arm C to move to the rear and straighten out the arm D, thus raising the entire wedge a little. Then the two arms, C and D, make a decreasing angle to the rear until the wedge is down to the loading position.

Two extractors are used, one on each side of the wedge. These are connected by a shaft fitted to revolve in a sleeve having a projection at one end. For this projection, a narrowing groove is cut in the lower forward side of the wedge. As the wedge falls the projection works in the narrowing groove, and causes the extractors to gradually withdraw the empty cartridge-case. At the narrow end of the groove the entire force exerted by the falling wedge is suddenly brought to bear on this projection, expelling the cartridge-case with great rapidity.

The following table contains the principal details and some ballistics of this gun:

Calibre		inches	2.6
Total weight		pounds	1,356
Preponderance		nearly	0.
Total length		calibres	42
Length of bore		do	40
Rifling.	Number of grooves		26
	Depth of grooves	inches	.039
Maximum recoil		inches	4.3
Weight of charge		pounds	4
Weight of projectile		do	8.8
Weight of cartridge case		do	3.5
Muzzle velocity obtained on trial		f. s.	2,067
Chamber pressures obtained on trial		tons per square inch	14.4 to 16.4

The velocity and pressures were obtained with ordinary powder.

THRONSEN RAPID-FIRE GUN.

This gun was manufactured at the Finspong Gun Foundry in Sweden, and took its name from its inventor, Mr. Harold Thronsen. The breech wedge is a falling block, operated by a lever coming out from the rear of the breech instead of, as is usual in other falling block types, from the side. The bore is 40 calibres in length and the gun is pointed from a shoulder rest. In trials of a 1.85-inch gun of this type in March of this year ten shots were fired within twenty-five seconds.

SMOKELESS POWDERS.

During the past year the subject of a suitable smokeless powder has engaged the attention of all the principal European powers.

The development of the full powers of machine and rapid-fire guns makes such a powder an almost absolute necessity, as its use renders possible both rapidity of fire and precision of aim.

When France adopted a smokeless powder for use with the Lebel rifle some five years ago, and succeeded in keeping its composition secret, many of the principal governments of Europe started separately on a series of experiments with the object of discovering a similar propellant.

At the present time Austria, England, Germany, Italy, and Switzerland are each said to possess a service smokeless powder.

The Japanese have also been experimenting in the same direction for a year or more.

Foreign publications state that the French military authorities have divulged the secret of the powder now used in the Lebel rifle (Vieille powder or Poudre B) to Russian officials for use with a magazine rifle lately adopted in Russia.

Italy has experimented with several varieties, and for a time used "Chilworth Special" in the rapid-fire guns of the "Piemonte." During the first part of this year, however, all experiments ceased, and the Nobel powder—ballistite—was officially adopted and a contract made for a large amount, in addition to which measures were taken looking to its future manufacture by the Government.

Exhaustive experiments have been carried on in England with several varieties of smokeless powder. It was found, as a general rule, that most of those tried were satisfactory as to comparative smokelessness, energy, and completeness of combustion, but were not able to retain their normal qualities a sufficient length of time to make them of practical value under the varying conditions of service afloat. We understand, however, that Cordite has finally been officially adopted for use with rapid-fire guns and the new magazine rifle.

In all powders experimented with up to the present time the principal objects sought have been to render detonation impossible by chemical and mechanical means, and to make use of some slowing agent which would result in the non-production of smoke and residue, and would give high and constant velocities with low and regular pressures.

Nothing definite is known concerning the powder adopted by Switzerland for use in the Schmidt rifle, but most excellent characteristics are being claimed for it.

The essential requisites of a perfect smokeless powder are: approximate smokelessness; completeness of combustion; high and regular velocities with moderate and regular pressures; stability under varying conditions of climate, temperature, and age; freedom from noxious or irrespirable gases.

In no powder yet produced has absolute smokelessness been obtained. The term is simply relative and signifies that the smoke given off on firing is so slight as not to obscure either the firer or object fired at, and so quickly dissipated as to admit of continuous firing. The character of the smoke has been illustrated by photographs of the simultaneous discharge of two high-power guns, one using a smokeless, the other an ordinary powder. In these the former shows a thin haze through which the firer is distinctly visible, while the latter shows a dense cloud which completely obscures him.

The smokeless gives better ballistic qualities than the ordinary powder, much smaller charges being required to produce equal velocities and chamber pressures. In its normal state it has a gradual and continuous action, giving a lower chamber pressure but higher pressures all along the walls of the gun. This will necessitate in the future construction of guns which are to use such powders, a decrease in the size of powder chamber and a strengthening of the walls of the chase. The absence of a fouling residue, which with ordinary powders acts as a lubricant, will cause so much friction, that oily cloths or other lubricating substances will have to be used from time to time.

All the smokeless powders now in use are surmised to be either nitro-compounds or picrates. Those which have nitrate of ammonia as a base are quite sure to be deliquescent and require to be kept in sealed cases. Fortunately the use of fixed ammunition renders this possible with small-arms and rapid-fire guns, but even under such circumstances these powders are very liable to change, and to develop varying pressures, when exposed to high temperatures for any length of time. In the magazine of a vessel stationed in the tropics this would be a source of anxiety, for any change in the composition, even if it did not result in the development of dangerous pressures, would render unreliable the sights of all guns for which the powder was intended.

Experiments are now being conducted looking to the production of a coating for these powders which will render them insensible to atmospheric influences.

The smokeless powder is a permanent innovation, however, and its use will prove of inestimable advantage in future naval actions, enabling a commander-in-chief to keep an enemy continually in view and to estimate the varying changes of distance; to deliver a more rapid and accurate fire; to see the effects of gun and torpedo fire, and to transmit his signals with the certainty of their being seen. In fleet actions its use will decrease the offensive power of the torpedo-boat, and increase the power of the gun and the importance of fleet tactics. In general, as between two opposing vessels of equal offensive and defensive power, its use will favor the one having the better firing discipline.

At the present time, owing to the peculiar relations existing between the various European powers, smokeless powders,—none of which are believed to have been thoroughly tested under all necessary conditions,—are in actual use ashore and afloat. The question has finally resolved itself into one of regularity of pressure under varying service conditions of climate, temperature, and age, and if this question is satisfactorily answered in the future we must then make use of the best means for their proper care and preservation in the magazines of naval vessels.

(BALLISTITE Nobel Powder).

From various sources we gather that this is a preparation containing nitro-cellulose, nitro-glycerine, and camphor, to which, during mixture, benzole is added to aid solution and afterwards evaporated.

It is claimed for this powder that it gives the stable and tempered velocity necessary to fit it for use in fire-arms; that it is not deliquescent; that it stands a high temperature without deterioration; that it leaves but a slight residue, and that it is nearly smokeless.

From the patent specifications of its inventor, Mr. Alfred Nobel, we take the following as one example of the preparation of this mixture.

It must be understood that the proportions here given are not absolute, they depending on the purpose for which the resulting powder is intended: Dissolve 10 parts by weight of camphor in 100 parts of nitroglycerine, and then add 200 parts of benzole. Carefully steep 50 parts of dry nitro-cotton pulp in this mixture and then evaporate the benzole. Then mix thoroughly by passing between steam heated rollers. When the mass becomes homogeneous, roll out into sheets, and finally cut up into grains or mold into any desired shape.

For small arms this powder is prepared in the form of cubical grains, but for larger guns, in strips of a square cross section which are cut the length of the cartridge case into which they are to go and are ignited by means of a detonating primer. The rate of combustion decreases with increase in size of grain or of cross-section of strip.

These strips are of a polished dark brown on the outside, and, when broken, present a section of a dark brown color with minute yellow specks. They burn quickly in the open air with a light hissing sound, and give off a bright yellow flame.

It is supposed that this was one of the powders used in the German army manœuvres of 1889, which was described by some of those present as practically smokeless, only a thin brown vapor being discernible from the flanks and scarcely anything at all from the front, but showing a vivid flash.

Extensive trials from rapid-fire guns were carried on at Krupp's last summer with this powder, during which some of it was soaked in water of a temperature of 17° C. for thirty minutes, then taken out and dried, and two charges of it fired from a 7.5 centimetre 28-calibre gun with the following results:

Weight of charge.	Weight of projectile.	Velocity at 131 feet from muzzle.	Chamber pressure. (tons per sq. in.)
Lbs.		*f. s.*	
1	15	1,424	10.4
1	15	1,424	10.5

In Germany this is officially known as C/89. (R. G. P. C/89). From an 8.27-inch, 35-calibre high power gun, a charge of 51.7 pounds of it has given to a 238-pounds projectile a muzzle velocity of 2329 f. s. with a chamber pressure of but 14.6 tons per square inch.

Ballistite has been definitely adopted by the Italian Government. During the past year the military authorities have ordered a quantity sufficient for 160,000,000 small-arm cartridges, the government reserving to itself the right to manufacture the powder for twelve years by the payment of a royalty of a fraction over 11 cents a pound. The Italians have also experimented with it in high-power guns with satisfactory results.

The first issues of the new English magazine rifle were sighted for a muzzle velocity of 2,200 f. s., using a Nobel powder.

In a recent speech in the Italian Chamber of Deputies, the minister of war stated that extensive experiments with ballistite had proved it to be in every respect satisfactory; that its chemical stability remained unchanged with a considerable increase of temperature, and that it could be transported without danger. Amongst other experiments, he stated that shots had been fired into cases of cartridges filled with ballistite without producing explosion, and that a cartridge had been exploded in a full packet of charged cartridges without detonating the others.

Reports of a later date state that a large quantity of this powder exploded at the Avigliano powder factory on May 16, 1890, killing many workmen, but no details have yet been published.

POUDRE B (Vieille Powder).

This, which is generally known under the name of Lebel powder, is the so-called smokeless powder used in the Lebel rifle, and is the invention of a Frenchman, M. Vieille, for which the French Academy of Sciences awarded him the Le Compte triennial prize.

Nothing definite is known as to its composition, the secret of which is jealously guarded by the French military authorities. It is claimed that it gives a high muzzle velocity with only a slight recoil, and with but little strain on the breech mechanism; and that it emits a very thin bluish smoke which quickly dissipates, and a comparatively feeble report.

In a lecture delivered by Sir F. Abel this year, the speaker stated that he had seen a few particles of this powder about two years ago; that they were in the form of small yellowish brown tablets about .07 to .10 of an inch square, of the thickness of stout note paper, and had evidently been produced by cutting up thin sheets of the material, and that they had appeared to contain, as an important ingredient, picric acid.

It is claimed that a muzzle velocity of 2,194 f. s. has been obtained from the Lebel rifle, using this powder, and with a comparatively low chamber pressure.

A French powder, known as BN., and supposed to be a modification of Poudre B., has given a muzzle velocity of 2,540 f. s. from a 24 centimetre (9.45-inch), 36-calibre, high-power gun, and of 2,749 f. s. from a 15 centimetre Canet rapid-fire gun.

As put up in cartridges the BN. is cut up into strips of about one-quarter-inch thickness, which are laid side by side, and packed in canvas bags for high-power guns, and in metallic cases for rapid-fire guns. It is stated that it cannot be fired without a priming charge, and that it gives but a small cloud of smoke, which quickly dissipates.

CHILWORTH SPECIAL.

This is the powder which has been used until lately in the Armstrong rapid-fire guns. It is probably simply an improvement on the Rhenish-Westphalian P. P. C '86, treated of on pp. 156 and 416, No. VIII.

The proportion of ingredients in its composition is surmised to be about as follows:

Nitrate of ammonia	38
Nitrate of potassium	42
Carbon (prepared as in Brown powder)	20

This powder was used in the ship trials of the *Piemonte's* rapid-fire guns, during which, we understand, it proved to be not absolutely smokeless, but only approximately so, such smoke as was given off being nearly transparent and soon dissipated. In firing to leeward on that occasion the target was never obscured for more than an instant of time.

The following is a tabulated statement of the results obtained with the Armstrong rapid-fire guns in competitive trials of this powder with brown prismatic (BP.) and pebble (P) powders:

Calibre of gun.	Weight of charge.	Powder used.	Weight of projectile.	Muzzle velocity.	Chamber pressure.
	Lbs.		*Lbs.*	*f. s.*	*Tons.*
4. 724 inches	12	P.	45	1, 850	15
	12	*CS.	45	2, 250	15. 5
6. 0 inches	60	BP.	100	2, 260	15
	38	*CS.	100	2, 340	16. 5

*Chilworth special.

At the present time all Chilworth special cartridges are put up in hermetically sealed metallic cases containing a cylindrical space through the middle, in which is placed a bag containing 1 pound of rifle large grain (R. L. G.) powder. It is thought to be of the same size and grain as BP. powder.

Sir William Armstrong has publicly stated that this powder leaves no residue in the bore to interfere with the essential requirements of rapid loading.

CORDITE.

This powder takes its name from the form in which it is made up. It is supposed to be composed of ordinary blasting gelatine with soluble nitro-cellulose added, and with a solvent sufficient to give it the consistency of a moderately thick jelly. This is pressed through holes to form cords, which at first are soft and pliable, but which become toughened after the evaporation of the solvent. Then these cords, which are either of a square or circular cross section, are cut the necessary lengths, and packed side by side in cartridge cases. The rate of burning depends on the thickness of the cord.

When ready for use it looks very much like ballistite.

It is of a chocolate brown color on the outside, and when broken, shows a light gray section much like fine grained pumice stone. When burned in the open air in small quantities it burns noiselessly and with moderate quickness, and gives off a bright yellow flame. When fired, it is said to leave no residue in the bore and to give off but a slight filmy vapor which disappears very quickly.

It is claimed that higher velocities and lower pressures have been obtained with charges but half the weight of those of ordinary gunpowder. Sir William Armstrong has asserted that in the 6-inch rapid-fire gun a velocity of 2,300 f. s. has been obtained from this powder with a pressure somewhat over 12 tons.

This powder has also been tested in Italy in the Armstrong rapid-fire guns. It has been exposed to a very high and to a very low temperature without being injuriously affected.

GELBITE.

This is a smokeless powder, invented by Dr. S. H. Emmens, and is obtained by treating specially prepared paper with emmensite. It is in the form of thick yellow paper, which, but for the pronounced yellow of its color, corresponds very well with Sir F. Abel's description of some particles of Poudre B seen by him.

In unofficial trials at the Washington navy-yard, from revolvers and rifles, this powder gave off but a slight dusty puff, which was very quickly dissipated, and which was accompanied by a sharp, quick report.

It is stated that a charge of 25 grains of this powder gives the same propulsive force as 70 grains of ordinary powder.

GRAKRUT (GRAY POWDER).

A Swedish powder, the invention of a Mr. Skoglund, and supposed to have a nitro-cellulose base.

It was tested during the past year from a 25 millimetre gun in comparison with the Belgian Wetteren powder, with the following results:

With a charge of the Grakrut equal to 70 per cent. of the other powder the initial velocity was increased 33 per cent., and the chamber pressure 5 per cent. With the charge of Grakrut decreased to 62 per cent., the initial velocity was increased 24 per cent. without any preceptible increase of chamber pressure. When a charge of 74 per cent. was used, the initial velocity was increased 40 per cent. without giving an undue pressure in the chamber.

In competitive tests from Nordenfeldt machine guns the smoke from ordinary powder was not dissipated for twenty-five seconds, while that from the Grakrut was in the form of a transparent vapor, remaining visible only five seconds.

Late information is to the effect that this powder has been tried in Russia with satisfactory results.

HENGST POWDER.

The claims advanced for this powder, as set forth on page 417, No. VIII, have been found by experiments to be practically substantiated.

From various sources we gather that the following is the method probably adopted in the manufacture of this powder.

Straw pulp—preferably that of oat straw—is treated with a mixture of two parts by weight of sulphuric acid to one of nitric acid for from fifteen to twenty hours, after which the acid is strained off and the pulp washed in water until no trace of acid remains. The mass is then steeped in a solution of hyposulphite of soda or other suitable alkaline solution, and then slowly dried. When dry it is compressed and then formed into grains or any other desired shape.

In competitive trials with ordinary black powder it gave increased velocities with smaller charges; it gave off but little smoke, and that only a light vapor which rapidly condensed and immediately afterwards disappeared; it left but little residue. Several rounds fired in rapid succession did no more than slightly warm the barrel, while an equal number fired with the ordinary black powder heated it considerably. In the dark it gave out a faint pale blue glow at each discharge.

Colonel Shakespeare, of the British army, made the following interesting experiments with this powder. He soaked two ounces in water for forty-eight hours and then dried it: When fired it was found to have been uninjured. He then boiled two ounces for forty minutes and dried it: When fired it was also found to have remained uninjured. He then steamed two ounces for twenty minutes on a copper-wire gauze, and alongside of it treated an equal quantity of black powder in the same manner: Without drying he fired them. The Hengst powder exploded, but rather slowly, while the black powder only fused.

Other experiments have proved this powder to be free from danger of explosion from friction or concussion, and it is considered to possess—weight for weight—about 150 per cent. greater strength than ordinary gunpowder.

SCHWAB'S SMOKELESS POWDER.

An Austrian powder invented by Major Schwab, the director of the Government powder factory at Stein, and recently subjected to exhaustive experiments.

Its composition has been kept secret, but military writers describe it as being of a gray-black color—more gray than black—and as having a very large grain, larger than is found with ordinary powders. It is said to burn very slowly in the open air, to give off a thin almost transparent vapor—like attenuated steam—and to emit a slight odor, very similar to that of ordinary powder. Made up into cartridges it is said to ignite rapidly and to give much higher velocities, with lower pressures, than ordinary powders. In one experiment from a field-piece this was the case, with a charge only 50 per cent. of that of ordinary powder.

With continuous volley-firing from small-arms it has been reported that the transparent vapor produced was only visible for a few yards in front of the firing party, and in no way impeded a constant view of the object which was being fired at.

It is asserted that this powder has been kept for four years without undergoing any chemical change.

HIGH EXPLOSIVES.

The problem of a suitable and safe high explosive for use in projectiles seems in a fair way to a practical solution.

The French appear to be thoroughly satisfied with mélinite, and assert that it has been so perfected as to be tractable, safe to manufacture, handle, and stow, and that it will not explode by concussion alone.

The English have made exhaustive experiments with lyddite, and are said to have succeeded in piercing a 5 inch steel plate before the charged shell exploded.

The Austrians are so well satisfied with the numerous experiments carried out this last year with ecrasite that the War Department has adopted it for use in the army. As already successfully experimented with, the weight of bursting charge of this explosive as compared with the weight of ordinary bursting charges in corresponding Austrian projectiles is given herewith:

Gun.	Weight of armor-piercing shell.	Weight of ordinary bursting charge.	Weight of ecrasite bursting charge.
	Lbs.	*Lbs.*	*Lbs.*
8.24-inch	206.6	4.4	15.88
6-inch	74.4	1.7	5.84

Most of the high explosives for shells now in use are either gun-cotten or picric acid compounds. It has been generally supposed that picric acid and its compounds were so susceptible to concussion that the mere act of striking against a thin armor-plate would be sufficient to cause shells containing them to explode before they could penetrate. But at the present time it is generally conceded that with some of these substances means have been found to delay explosion until after a certain degree of penetration.

The results of experiments thus far carried out have been sufficiently pronounced to develop a general feeling in favor of an increase in the extent of armor protection for war vessels.

Following are a few details that have been gathered from various sources in regard to the principal high explosives which have attracted attention during the past year:

ECRASITE.

This is supposed to be a composition of blasting gelatine treated with the sulphate or hydrochlorate of ammonia, or both, and is reported to be as well adapted for use in small arm cartridges as for bursting charges for shells.

Extensive private trials have been conducted in Austria and the effects produced have been stated to resemble those ascribed to mélinite. It is said to be exceedingly powerful, and in no way sensitive to mechanical and atmospheric influences.

In one experiment an armored tower surmounted by a 6-inch thick armored cupola, was used as a target. A shell filled with ecrasite penetrated the cupola and burst inside, destroying the inner parts of the tower and shattering its walls.

To show its insensibility to mechanical influences, a shell charged with this explosive was fired at a target composed of three 4-inch plates of steel placed close together, of an aggregate thickness of 12 inches. The shell perforated the two first plates and buried itself in the third without exploding.

It is said to be perfectly safe to handle, and its effects, as compared with those of dynamite, are stated to be as 10 to 7.

The numerous private experiments carried out with ecrasite, in connection with its adoption by the Austro-Hungarian military authorities, and the strenuous efforts made to guard the secret of its manufacture, indicate that it is considered a valuable explosive for military purposes.

EMMENSITE.

In addition to the article describing this explosive contained in No. VIII, we have to describe an interesting set of experiments carried out by its inventor, Dr. S. H. Emmens, this year at the Washington navy-yard.

The grade of emmensite experimented with was composed of one pound each of the following substances: (1) The combustible (nitrated carbolic acid). (2) Nitrate of soda. (3) Nitrate of ammonia. These were incorporated in the following manner:

The combustible was placed in an earthen dish and heated over a fire of a temperature of 250° F. until it became semi-liquid. Then (2) and (3) were added in small quantities at a time, the mixture being stirred continually until it finally developed into a yellow paste, which, when taken off of the fire and cooled, hardened and assumed a yellow color and crystalline appearance.

This substance was then placed in a mortar and pulverized with a pestle, the operation being performed apparently with no thought of any danger from explosion.

The resulting substance is known as emmensite and is manufactured in five different grades.

The inventor took about a spoonful of this substance and lighted it, when it burned very feebly, melting into a dark resinous mass. He then took some of it, which had previously been mixed with charcoal as a reducing agent, and tried it from a pistol; it gave a sharp snap for a report and emitted but a slight whiff of very thin smoke.

A charge of about 60 pounds of the emmensite was then placed under a raft composed of forty ordinary railroad ties securely bolted together, and exploded by means of an electric fuze; pieces of the raft were blown to a height of over 200 feet and not a single tie was left intact.

Two 7-ounce cartridges, one of dynamite and one of emmensite, were hit by shots from a 32-calibre rifle. The former exploded, but the latter, although broken into two pieces, did not.

Seven-ounce cartridges of emmensite were separately placed against the top, the sides and the bottom of ⅝-inch iron plates and exploded; in each instance the plate was badly broken.

A cylindrical tin case, about 1½ inches in diameter and 5 inches long, was filled with emmensite, made as above described in the presence of the witnesses of these tests, and fired from a small gun; it perforated a 2-inch board without exploding.

Ensign Brainard, U. S. Navy, writes as follows of some of a number of interesting experiments witnessed by him at Dr. Emmen's manufactory.

> Four 9-ounce emmensite cartridges were placed in a cylindrical tin can and the spaces between them were filled with gunpowder, about a pound and a half being used. The powder was exploded with an ordinary blasting time fuze. The cartridges were fractured, but not exploded. Parts of them I gathered, and being bunched together, they were exploded by a fuze embedded in the emmensite. I believe that only the piece in which the fuze was embedded exploded, and that the two thicknesses of heavy paper between it and the other pieces prevented their explosion.
>
> Ten 9-ounce cartridges, said to contain emmensite, were then placed in a wooden box and the box placed on a bonfire. The emmensite burned, but did not explode. I was told that 45 pounds of emmensite had dislocated 775 cubic yards of stone weighing about 1,550 tons.

The A-explosive, referred to in the foot note on page 412, No. VIII, was not a production of Dr. Emmens, nor was such an inference intended. The reference to emmensite was by mistake.

EXTRALITE.

This is the invention of Rudolph Sjöberg of Sweden, and its principal ingredients are an ammoniacal salt (either nitrate or oxalate of ammonia), a hydrocarbon, and chlorate of potash. The following are examples of proportions of these ingredients, but these proportions may be varied according as the resultant compound is intended to be used either for blasting or military purposes.

50 parts nitrate of ammonia,		50 parts oxalate of ammonia,
5 parts carbonate of ammonia,		10 parts liquid hydrocarbon,
10 parts liquid hydrocarbon,	or	5 parts solid hydrocarbon.
5 parts solid hydrocarbon,		35 parts chlorate of potash.
30 parts chlorate of potash,		

This explosive looks like corn-meal. The following characteristics are ascribed to it. That it can not be exploded except within rigid inclosures and then only by the use of a percussion cap; that it can not be exploded by concussion, and that it is perfectly safe to handle.

It is understood that Mr. Rudolph Ericsson experimented with this explosive with the following results:

He placed 2 pounds of it in a charcoal fire in the open air, and it burned slowly away, but did not explode. A percussion primer, when attached to a half-pound cartridge and fired in the open air, simply ruptured without exploding the cartridge. A full cartridge was pounded to bits by a stone, but did not explode. Then he filled a tin can with the explosive, and, standing but a few feet away, shot a bullet through the can without exploding its contents. Its effects for blasting purposes were then shown to be most powerful.

LYDDITE.

This high explosive, now in use by the English military authorities, is supposed to have been the original mélinite. Its inventor, M. Turpin, is said to have sold his patent rights to Sir William Armstrong for a large sum.

It is believed to be a picric acid compound, composed of chloro-picrin, chloride of picryl, naphthaline, iodo, dinitro, and other phenols.

It is stated in foreign journals that those who visited the *Resistance*, after experiments were made on her with shells charged with this explosive, found that the destruction wrought by the bursting of these shells within the ship had been terrific—almost incredible in its extent and thoroughness.

English newspapers state that this explosive is considered so safe in handling that the railway companies accept it for transit without objection.

MÉLINITE.

This high explosive has been referred to in previous publications of this office. As originally invented it was a composition the principal ingredient of which was melted picric acid.

Since that time the French pretend to have so modified and perfected the original invention as to have made it a safe explosive in manufacture, handling, and stowage, and they point with pride to the fact that but one accident has occurred from its use in three years. No mélinite shell has ever burst in a gun and no accident has ever occurred in drawing the charges from shells.

Many foreign journals admit that the French use this explosive with the utmost confidence.

Its present composition is not definitely known, but it is generally believed to contain picric acid as its chief constituent, either mixed with some oxidizing substance or simply made into a compact mass with collodion. Late information leads to the belief that mélinite is not used alone as an explosive in shells, but has joined with it a substance known as cresilite, which is said to add greatly to its stability and to its safety in handling.

This cresilite, which is supposed to be a nitro-cresol, a substance obtained from a coal-tar product, is first put in the shell in sufficient amount to take up two-thirds the space. Mélinite is then rammed in by means of mallets to fill the remaining one-third of the space. It is stated that it can be exploded only by means of a powerful detonator.

France is reported to have a full supply of mélinite shells all ready for use afloat and ashore.

In the 155 millimetre (6.1 inch) gun the high explosive shell is to be 5 calibres long, to weigh 121.2 pounds, and to contain a bursting charge of mélinite weighing 22.8 pounds. The common shell now in use with this gun is 3 calibres long, weighs 88.2 pounds, and contains a bursting charge of 3.1 pounds.

SMALL-ARMS.

The steady progress of invention in small-arms has resulted during the past year in the adoption of new magazine rifles by Belgium, Denmark, England, Germany, and Switzerland.

Common report has it that Russia has decided to adopt a magazine rifle to take the Lebel rifle ammunition, and to have a detachable under-box magazine to hold five cartridges.

It is understood that experiments are being conducted in Japan looking to the adoption, in place of the Murata, of a .315 calibre rifle, having a detachable under-box magazine to hold 6 cartridges.

China is reported to contemplate the adoption of the new English magazine rifle.

Chili and Bulgaria have adopted an improved Mannlicher, a weapon very similar to the Austrian arm, but constructed to use smokeless powder.

The following table contains some of the principal features of the modern small-arms now adopted in Europe:

Nation.	Calibre.	Weight.	Name or type.	Type of magazine.	Number cartridges in magazine.	Number rounds carried per man.	Arranged to cut off magazine.
	Inches.	*Pounds.*					
Austria	.315	9.68	Mannlicher	Vertical fixed box	5	100	No.
Belgium	.301	8.6	Mauser	Detachable box	5		do.
Denmark	.315	9.4	Krag-Jörgensen	Horizontal fixed box	5	120	Yes.
England	.303	9.13	Lee (type)	Detachable box	8	116	do.
France	.315	9.19	Lebel	Under tubular	8	112	do.
Germany	.311	8.38	Mannlicher (type)	Vertical fixed box	5	150	No.
Switzerland	.295	9.68	Schmidt	do	12	164	Yes.

The immense expenditure of money necessary for a new arm, and the great length of time essential for the fabrication of the number required to supply an army of any of these nations, renders it probable that no radical change will be made in the above equipment for some years to come. As it is, European factories have government orders ahead now sufficient to keep them busy for two years.

All the above rifles are of small calibre and give high velocities, low trajectories, and great range. They differ principally in the method adopted to gain magazine fire.

The French rifle embodies a magazine system—the tubular—which has been extensively used in the past, but has now given way to an under-box system, either fixed or detachable. The fixed under-box magazine is preferred, as is evidenced by its more general use. It permits of greater rapidity of loading than any other, and has only one serious objection urged against it, that of the danger of the gun being rendered useless by any damage to the fixed box.

The anticipated muzzle velocities from these modern rifles will not vary much from 2,200 f. s.

With the Austrian Mannlicher much trouble has been found in using smokeless powders, in some cases the gun-barrels having burst. This was because the type was originally constructed to use ordinary powders, which give much lower bore pressures. This difficulty will not be met with in future guns of this type as they will be constructed to use smokeless powders.

Following will be found some details of the lately adopted small-arms:

AUSTRIA. (Mannlicher, M. 88.)

The Mannlicher, described in No. VIII, was designed to use cartridges of black powder, the charges of which are greater in bulk than corresponding charges of smokeless powder.

In order to use the latter, the entire piece would have to be altered, but to avoid the great expense of so doing, the Austrian military authorities have decided to retain the same size of cartridge case by adding to the charge of smokeless powder a sufficient quantity of some neutral material to bring up its bulk to that of the black powder charge. A necessary change will be that of the sights, which must be graduated for the new powder.

The increase of pressure along the bore when using smokeless powder will necessitate stronger barrels than are now used in this gun. Report has it that many have already burst from the effects of the higher pressures.

BELGIUM. (Mauser, M. 89.)

After exhaustive competitive tests of many different designs of small-arms, the Belgium Government has finally adopted an improved Mauser for its army, and is now having it manufactured for service.

It is of 301 calibre, on the bolt system, and is intended to take a soft lead bullet incased in a German silver envelope. Its magazine, which contains five cartridges, is placed forward of the guard under the breech casing.

The magazine box can be made fixed or detachable at pleasure. It is so constructed that while attached to the gun it can be filled by hand, and single cartridges can be replaced as they are used.

The cost of manufacture of this rifle is reported to average about $16.

The barrel is enveloped by a steel mantlet which acts as a protection to the hand, and also to preserve the gun-barrel from the wear of rough usage in service.

The cartridges are to be carried in packet chargers containing five each, and so arranged that the cartridges can be pressed out into the magazine.

The piece is arranged to be locked by means of a small lug on the rear of the bolt, which, when turned to the right to a horizontal position, acts to so hold the firing pin that it can not touch the cartridge.

Following are some details of this weapon:

Calibre	inches	.301
Weight:		
Without bayonet	pounds	8.6
With bayonet	do	9.4
Length:		
Without bayonet	inches	50.2
With bayonet	do	60.0
Rifling:		
Length	do	28.7
Number of grooves		4
Depth	inches	.014
Width	do	.165
Weight of charge	grains	54
Weight of bullet	do	216

DENMARK. (Krag-Jörgensen.)

Denmark has adopted the Krag-Jörgensen rifle for the army.

In this gun, which is of .315 calibre, the magazine is a horizontal fixed box under the breech casing which curves up to the cartridge opening on the left side of the gun. This magazine is constructed to contain five cartridges, which are to be loaded into it from tin chargers. A cut off in the rear of the magazine permits the use of the gun as a single loader.

The barrel of this gun is incased in a metal envelope very similar to that of the new German rifle.

The following details have been reported:

Length of gun	feet	4.35
Total weight	pounds	9.4
Rifling:		
Number of grooves		6
Twist, one turn in	inches	11.8
Weight of bullet	grains	237.6
Initial velocity	f. s.	2,099

ENGLAND.

The English Government has definitely adopted the small arm referred to on pp. 405 and 406, No. VIII, and is now issuing it to the army. As yet it has received no official designation.

The following are additional to the details published in the preceding volume of this series:

The magazine is a sheet-steel box, A, Fig. 1, which is inserted through an opening in the body from underneath in front of the trigger-guard, and held in place by a spring, *a*, Fig. 3, engaging in a notch in the magazine. It is secured to the gun by a few links of steel chain. A cut-off, B, Fig. 2, is fitted to the right side of the body, which, when pressed in, cuts off the further supply of cartridges from the magazine and permits the gun to be used as a single loader. The magazine can be freed from the gun by pressing the lever *b*, Fig. 3, inside the trigger-guard.

The cartridges, eight in number, are packed in the magazine half riding one another, Fig. 3, and rest on a movable platform which is pressed up by the spring *c*, Fig. 3, to feed the cartridges to the chamber.

The breech action is on the bolt system, and the cocking piece is so arranged that the gun can be carried at half-cock. A solid rib of steel takes the recoil on the right of the bolt and a solid steel lug on the left. The firing-pin and its spring are in the heart of the bolt, which, when forced home, holds back the pin and compresses the spring. If the bolt is not pushed close home the pulling of the trigger will completely close it before firing. A safety catch is fitted on the left side, which, if pulled back when the piece is at full cock, will lock the firing mechanism. There is a gas escape on each side of the breech and one in the bolt-head. Removable covers are fitted to the bolt and bolt-head, and a wooden hand-guard is fitted over the rear end of the barrel to protect the hand when the barrel gets hot from rapid or continuous firing.

Two sets of sights are furnished for this rifle; one for ordinary sighting, which is graduated up to 1,900 yards, and the other for long-distance sighting, which is graduated from 1,800 yards up to 3,500 yards.

For ranges up to 1,900 yards the fore sight consists of a rectangular block *a*, Fig. 5, with a narrow slit down the middle. The rear sight, Fig. 6, consists of a hinged flap with a sliding bar *b*. This bar has its upper edge beveled, with a square notch, *c*, cut in the middle, from the center of which a fine white line, *d*, runs vertically downward. The notch is of such a size that when accurate aim is taken the rectangular muzzle block forming the foresight exactly fills it, thus making the line of light seen through the slit in the foresight form a continuous line with the white line running downward from the notch of the rear sight The bad point about this sight is the liability of the slit filling up in dusty or rainy weather.

For long-distance sighting both sights, Fig. 4, are fitted to the left side of the gun. The rear sight, *e*, is simply a disk containing a circular

PLATE I

The New English Rifle

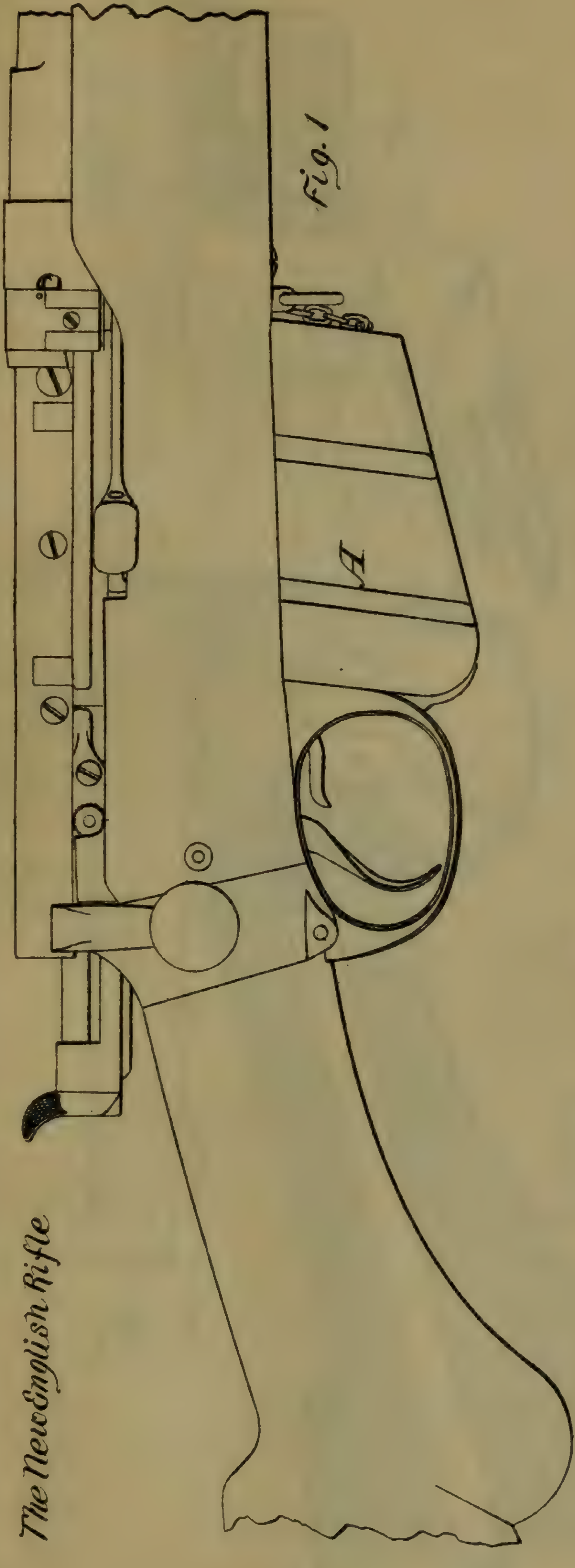


Fig. 1

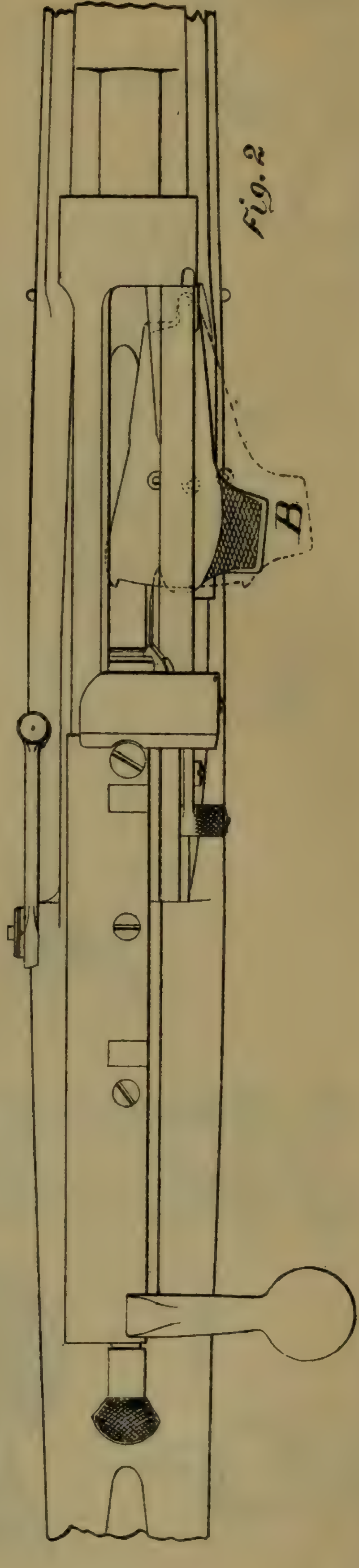
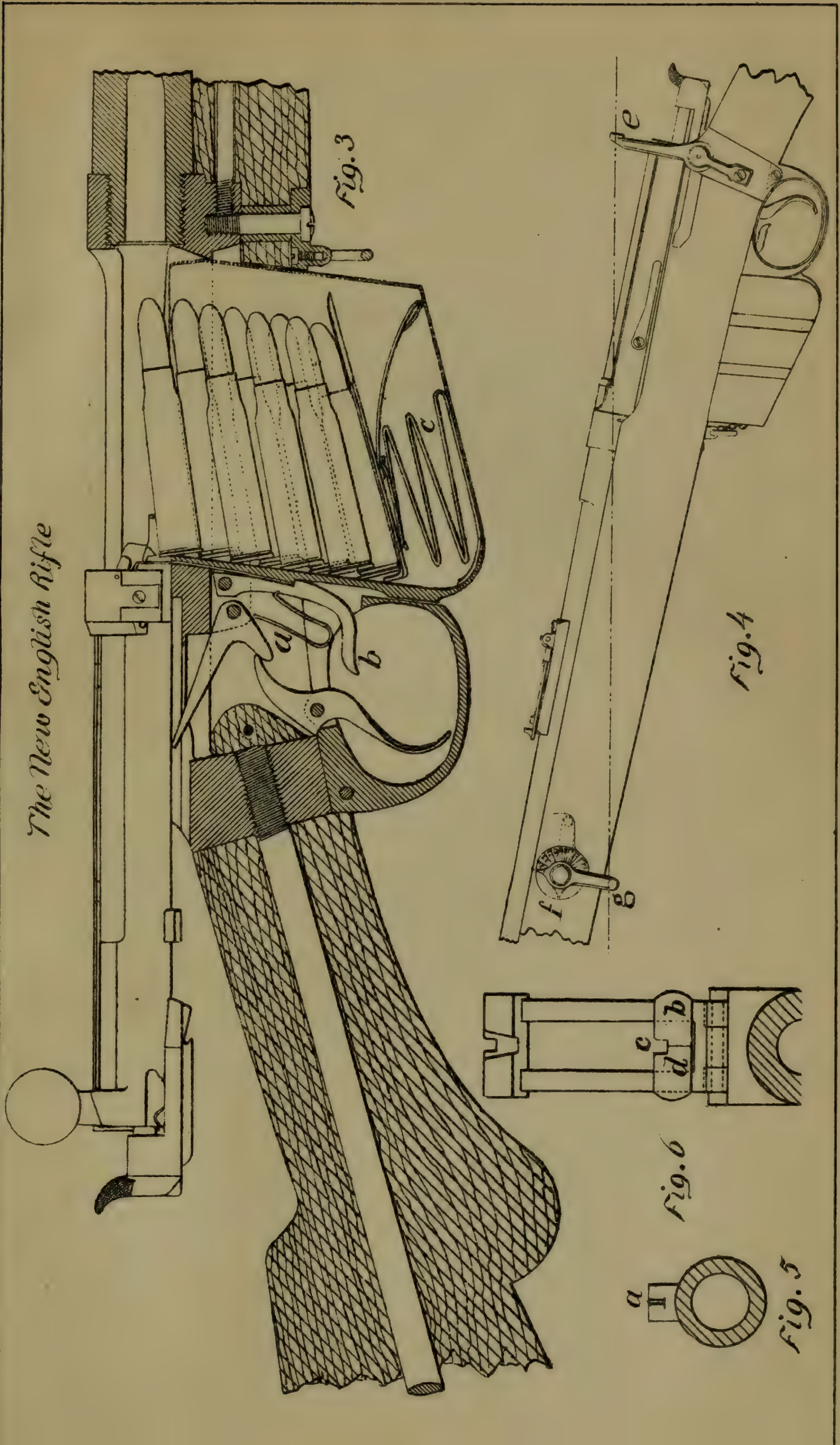


Fig. 2

PLATE 2



The New English Rifle

German Rifle, Model of 1888

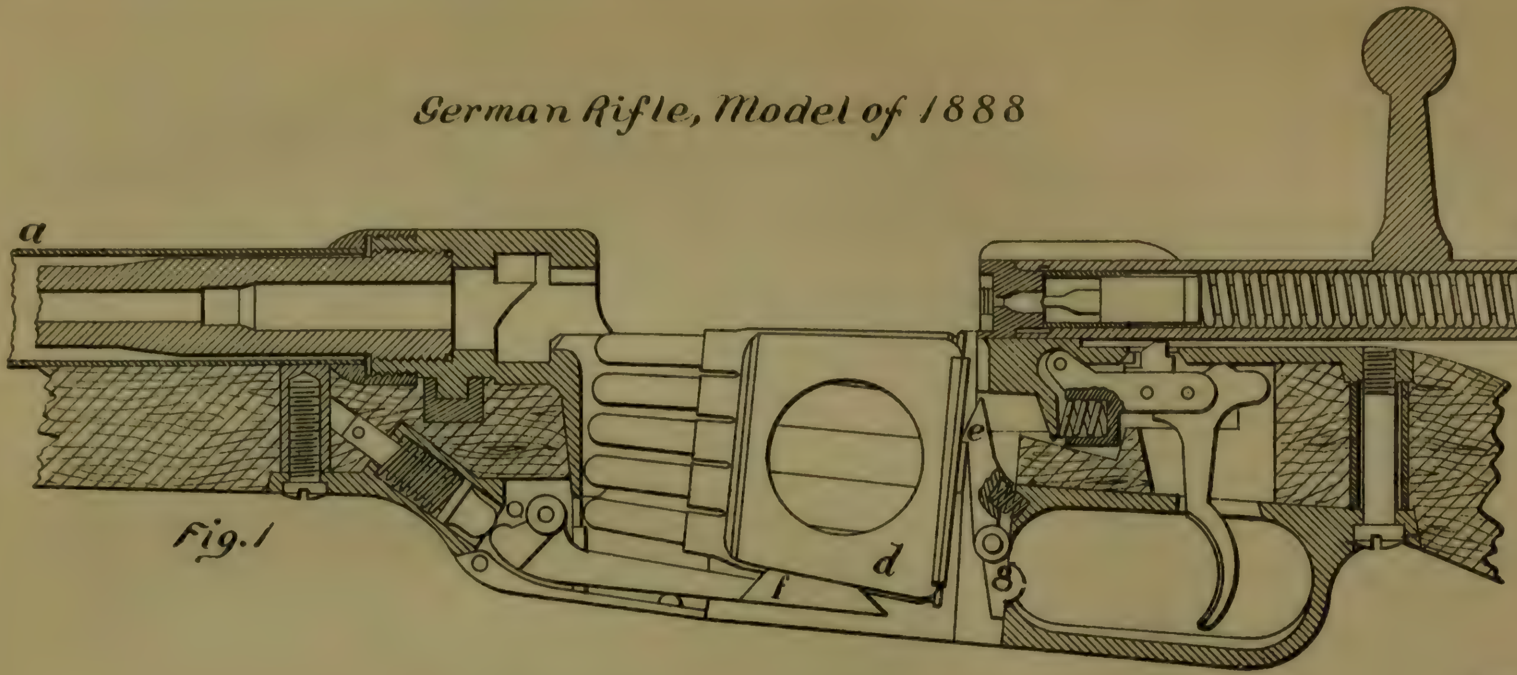


Fig. 1

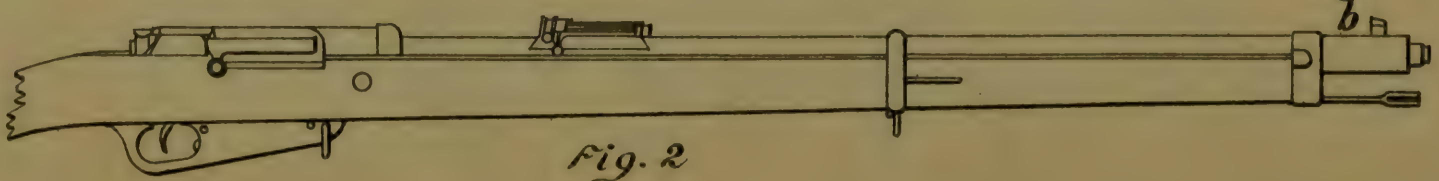


Fig. 2

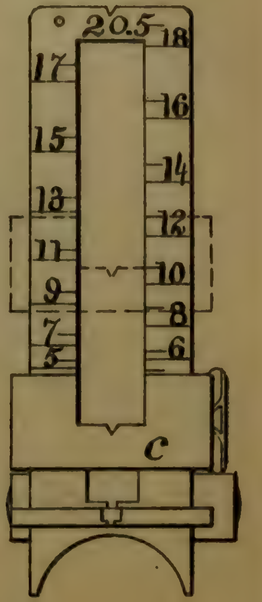


Fig. 3

aperture. The front sight, *f*, is a dial graduated from 1,800 to 3,500 yards, on which is a revolving index hand, *g*. On this index hand is a bead, which, when set at the distance required, is brought in line with the aperture in the rear sight.

The following details may prove of interest:

Muzzle velocity obtained with ordinary powder	foot seconds	1,830
Muzzle velocity obtained with cordite	do	2,250
Point blank range, flap down	yards	300
Angle of elevation for a range of 1,000 yards		1° 40′.37

GERMANY. (Infantry rifle, 1888.)

The German Government has finally decided upon the details of its new infantry arm and entered upon its manufacture.

There is no wooden guard for the hand, as in the English rifle, but instead, the barrel is enveloped in a metallic case *a*, Fig. 1, which absorbs heat very slowly and forms a protection not only to the hand but also to the barrel, preserving the latter from the wear and tear of rough usage in service. The sights are secured to this envelope.

The front sight *b*, Fig. 2, is a knife-edge set vertically in a sight-mass. The rear sight, Fig. 3, consists of a hinged flap and a sliding bar *c*. The flap is graduated in hundreds of metres, with a final graduation at 2,050 metres. In aiming, the bottom of the notch in the sliding bar is intended to be brought in line with the knife-edge of the foresight.

The magazine box is fixed. The magazine charger *d*, Fig. 1, is a light tin frame containing five rimless cartridges, lying one above another, with a groove,—which is cut in near the base of each,—taking in vertical projections at the rear end of the charger, and with the horizontal edges of the charger curved in to hold the cartridges in place.

The charger is introduced and pushed down from above until a projection on its rear face takes under the catch *e*. As the cartridges are discharged the carrier-plate *f*, Fig. 1, moves up between the sides of the charger until the last cartridge enters the chamber, when the empty charger, having nothing to sustain it, drops down and out. To remove the charger before the last cartridge is out, draw the bolt to the rear, press against the lever at *g*, Fig. 1, and then draw the charger up and out.

To lock the piece, a small vertical lip *h*, Fig. 1, on top of the rear of the bolt, is moved to the right, to a horizontal position, when, even though the trigger be pulled, the firing-pin can not touch the cartridge.

The cartridge case is rimless, but has a small groove cut in near the base to admit the head of the extractor. The bullet is of lead, incased in German silver. For target practice with this arm a hollow bullet of brass is to be used. For blank cartridges a hollow wooden bullet is to be used.

Each soldier is to carry two cartridge boxes in front containing 12 chargers of 5 cartridges each, and one cartridge box behind containing 18 chargers of 5 cartridges each, a total of 150 cartridges, which, with their accompanying chargers, weigh 10¼ pounds.

The following details have appeared in German publications:

Calibre of gun	inches	.311
Length, without bayonet	feet	4.08
Length, with bayonet	do	4.76
Weight, without bayonet	pounds	8.38
Weight, with bayonet	do	9.26
Weight of round	grains	416.6
Length of round	inches	3.23
Weight of powder charge	grains	38.6
Weight of bullet	do	223.7
Length of bullet	inches	1.06
Rifling:		
Number of grooves		4
Length	inches	28.35
Twist, one turn in	do	9.45
Weight of charger filled	ounces	5.46
Maximum range (elevation, 32°)	yards	4,153
Initial velocity (estimated)	f. s.	2,034
Sights graduated to	yards	2,242
Average rate of fire per minute		18
Penetration in wood (dry fir) at a distance of a mile	inches	2

SWITZERLAND (Schmidt).

The Schmidt magazine-rifle has been officially adopted in Switzerland and is now being manufactured for issue to the infantry. The following details have been gathered from foreign journals.

Calibre	inches	.295
Weight of smokeless powder charge	grains	40.3
Weight of bullet	do	221.3
Muzzle velocity	f. s.	2,362
Estimated rate of fire per minute		30

This is a bolt-gun in which a to-and-fro movement of the bolt suffices to extract the empty cartridge-case, introduce a new cartridge from the magazine, and make ready for use, in consequence of which the soldier is enabled to fire continuously without removing the piece from his shoulder so long as there are cartridges in the magazine. By means of a cut-off, the gun can be used either as a magazine-arm or as a single loader.

The magazine is fixed and differs from the Mannlicher type in being closed at the bottom. It is fitted to contain 12 cartridges placed to partly ride each other and is filled from the top, being so arranged that it can either be fully charged at once or have its cartridges entered one by one.

The bullet is of lead encased in an envelope of nickel-steel.

A wooden guard is fitted to the barrel between the sights, and the gun is sighted up to 2,624 yards.

Each soldier using this arm is to carry 8 chargers of 6 cartridges each in a box; 16 chargers of 6 cartridges each in a haversack; and 20 loose cartridges in a pouch—a total of 164 cartridges.

ARMOR AND ARMOR PROTECTION.

But few practical trials of armor-plates have taken place lately. The only one of note, described in detail below, being unsatisfactory in that it only included compound plates.

Nickel-steel plates are now being manufactured in France and England, but as yet, no trials have been reported.

TRIAL OF A CAMMELL COMPOUND ARMOR PLATE.

The following account of this trial, which took place in April of this year, is taken from the Admiralty and Horse Guard's Gazette of May 3, 1890:

> The plate in this instance measured 8 by 6 feet, and weighed 10½ tons. Its total thickness of steel and iron combined was 10½ inches, and as it was fired at by the 6-inch breech-loader, with full charges, at a close range of 30 feet, the result was supposed to represent, according to admiralty formula, what would be its behavior under the impact of heavy ordnance at long range. The plate was attacked with a couple of Palliser chilled shells and three hard steel Holtzer projectiles, each of the rounds having a velocity of 2,000 feet. The angles of the armor were first assailed, and after it had been thus thoroughly tested, a fifth round, with a steel shot, was directed at the center. The chilled projectiles were reduced to little more than dust by collision with the steel face, while the French projectiles were considerably splintered, the heads remaining embedded in the plate. At the fifth round, which was fired after the target had heated and undergone some amount of degeneration in fibre, the projectile touched the backing. A few cracks were produced, but it was evident that under the prescribed test the crew of a ship would have been protected against shell fire.

HELDER TRIALS.

Competitive trials of four compound armor-plates took place in November last off Helder, North Holland, under the direction of the Dutch Government.

Three of the plates were manufactured on the Wilson system by Cammell, St. Chamond, and Marrel, respectively, and the fourth on the Ellis system by Brown. The Cammell and Brown plates were made in England, the others in France.

All the plates were of the same dimensions—9 feet long, 6 feet 11.06 inches wide, and 11.02 inches thick, and were placed side by side on the deck of a large barge in the following order: St. Chamond, Marrel, Brown, Cammell.

Each plate weighed about 12.5 tons and was bolted to a backing consisting of a layer of 12-inch horizontal teak balks; another of 12-inch vertical teak balks, with two ¾-inch steel plates at the back, all held up by heavy timber struts.

Each maker was permitted to use as many bolts as he pleased, and it is understood that St. Chamond used 30, Marrel 20, Cammell 12, and Brown 8.

The trial, which occupied two days, was conducted from a man-of-war anchored about 87 yards from the barge.

Gun used	Krupp 28-centimetre (11.02-inch), 27-ton B. L. R.	
Weight of charge	pounds	121.3
Weight of forged steel projectile	do	566.6
Striking velocity	f. s.	1,355
Striking energy	f. t.	7,079
Calculated penetration in wrought-iron	inches	14.7

(See accompanying plate illustrating effect of each shot.)

The trial by shots resulted as follows:

First shot. (St. Chamond plate.) Completely through plate and backing, breaking the plate into three pieces, and throwing a large number of fragments to some distance.

Second shot. (Cammell plate.) Completely through plate and backing and developing surface cracks.

Third shot. (Marrel plate.) Completely through plate and backing and well to the rear, breaking the plate into three pieces and developing a number of large cracks.

Fourth shot. (Brown plate.) Projectile failed to perforate but broke up, leaving its head in the plate and developing several slight cracks.

Fifth shot. (Cammell plate.) Completely through plate and backing, detaching a strip of the hard face of the plate about 6 inches wide, between the holes made by the two shots fired, and exposing the soft back. One through crack about the middle of the right-hand edge, and developing several new surface cracks. The original cracks were somewhat extended.

Sixth shot. (Brown plate.) Projectile failed to perforate but broke up, leaving its head in the plate and dislodging a part of the head left in at the first shot. A through crack at the middle of each edge and several surface cracks were developed. All the previous cracks were deepened and extended.

Seventh shot. (Brown plate.) Completely through plate and backing, rupturing the plate into two parts, breaking off a large fragment, and splintering off the hard face for some distance around the edges of the broken parts.

Eighth shot. (Cammell plate.) Completely through plate and backing. Many new surface cracks, and old cracks deepened and extended. Hard face separated from soft back over a considerable space and thrown down, but plate still in one piece.

Ninth shot. (Marrel plate.) Completely through plate and backing. Hard face splintered off in a number of places and new cracks developed, several wide through ones and several on the surface.

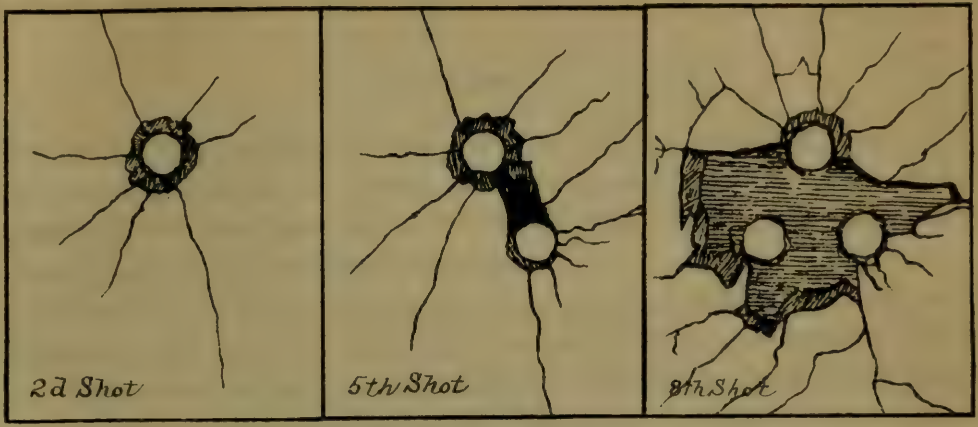
Tenth shot. (St. Chamond plate.) Completely through plate and backing. Plate completely ruptured from the first shot hole to the bottom, and hard face much splintered off. Plate badly shaken up.

At this stage of the proceedings the barge was found to be leaking so badly that the trial had to be concluded.

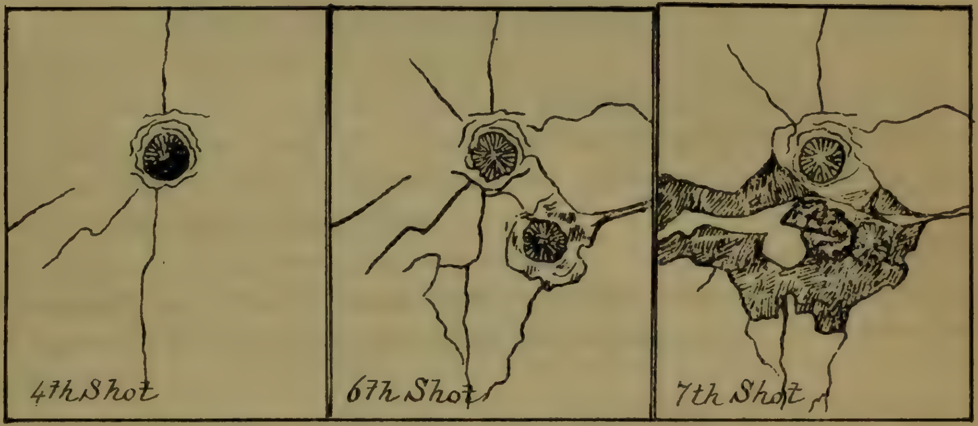
This trial resulted in favor of the English-made plates. Both French plates were originally somewhat weakened by the greater number of bolts used in securing them to the backing.

PROTECTION OF BUOYANCY.

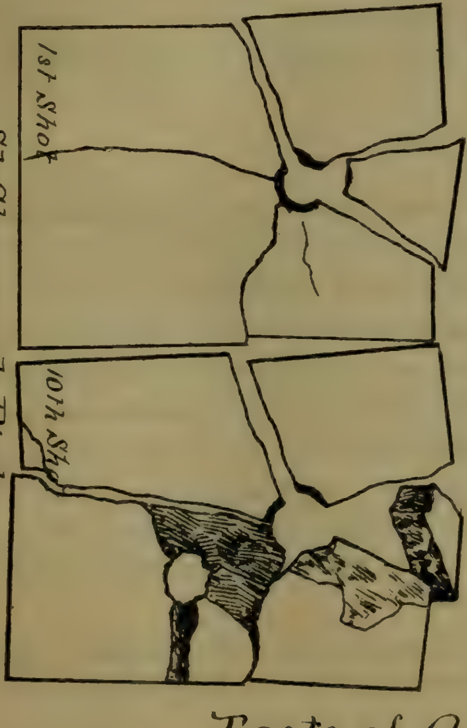
For years the attention of naval experts has been directed to the discovery of some elastic and buoyant packing material, which, while subject to the penetration of projectiles, would be so elastic as to immediately close the opening made and prevent the inflow of water.



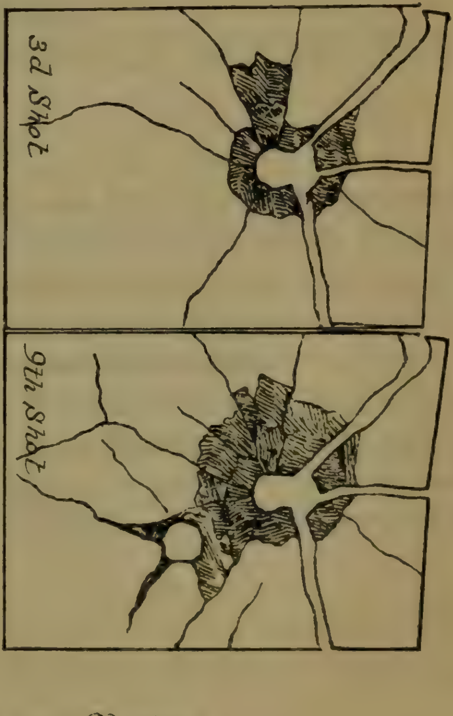
Cammell Plates



Brown Plates



St Chamond Plates



Marrel Plates

Tests of Armor Plates

For this purpose cellulose and woodite are the principal substances which have been prominently brought forward during the past five years.

CELLULOSE.

This material is composed of the ground fibre of the cocoanut, which has been first treated for the removal of the glutinous portions. It has the appearance of brownish meal mixed in with small grains, and possesses the property of swelling when wet.

It is used either in the ordinary form as above described, mixed with an additional 6 per cent. by weight of cocoanut fibre, or compressed in the form of so-called briquettes, in which the sides are compressed to the thickness of about half an inch and the interior filled with loose cellulose. In the ordinary form it will burn slowly, but when compressed it is difficult to either light it or to make it burn. Its specific gravity is very low, a cubic foot of the ordinary weighing but 7.5 pounds, and a briquette of a cubic foot, 8.1 pounds.

When packed in compartments it is preserved from direct contact with the metal of the ship by a thick coating of paint on the latter, as, if dampened from leaks or otherwise, the portion in contact with the metal will be certain to deteriorate.

Those opposed to the use of cellulose assert that it is unhealthful and breeds vermin, and that in consequence of the glucose not being completely removed during its preparation, deterioration and foul odors are inevitable.

Notwithstanding these objections, however, this material, during the past six years, has been placed in about forty vessels of the French navy and a number of vessels of the Russian, Dutch, Japanese, and Greek navies.

The cost of cellulose is about $350 per ton.

This substance is referred to on page 80, No. V, and page 121, No. VIII.

WOODITE.

This material, which is referred to on page 121, No. VIII, has a base of India rubber, from which it is prepared by a process which does not deprive it of its elasticity, and which is said to preserve it from deterioration from fire, water, and all other usual causes of decay. It is now manufactured in two types—the buoyant and the elastic.

Buoyant woodite has the appearance of cork chips held together by India rubber, and, as its name implies, is intended to be used only to supply buoyant properties. It weighs about 14 pounds per cubic foot, and costs about $225 per ton. Its manufacturers claim an actual resistance to absorption as follows:

	Ounces.
Weight of a 6-inch cube before immersion in water	27.75
Weight after twenty-four hours' immersion	32.50

Thus, about 4 per cent. of the space had been taken up by water at the end of twenty-four hours.

At the request of the manufacturers, Mr. F. K. Barnes, a former chief constructor of the British navy, made many experiments with this material. The following account of the most trying one is taken from his report thereon:

> The material used for the absorption trial measured exactly one cubic foot. It was incased on five sides in a tin case, the sixth side or cover being left off for the purposes of the trial. The weight of the block, with its case complete, was 21 pounds 1½ ounces. After taking the weight carefully I thrust a long probe into the material all over the uncased side, nearly to the bottom, so that the material was damaged all through, and honey-combed to such an extent as might perhaps occur in a very extreme case when the material is fired at.
>
> The block thus damaged was placed in an iron tank filled with water. The material was kept well under water and secured there by struts placed against a projecting rim of the tank. It remained there for twenty-four hours. At the end of the twenty-four hours the struts which secured it were removed and the block floated. It was at once placed with the uncased side uppermost, so that all the water which the damaged material had take up should remain in it. The block, on being weighed, scaled exactly 37 pounds.
>
> On the supposition, therefore, that some of the material could be as seriously damaged, when the ship containing it was under fire, as the sample operated upon, every foot of it so damaged would take up one-fourth of the weight of the same bulk of water.

Elastic woodite is made up in rectangular blocks, is very elastic, and has only obturating qualities claimed for it. It weighs about 64 pounds per cubic foot, and a thickness of one inch is said to be sufficient to stop the inflowing of water from the penetration of 6-pounder projectiles. It looks very much like India rubber.

In some experiments several years ago, blocks 8 inches in thickness were vulcanized to a ⅜-inch iron plate backed by a second plate of the same thickness, and fired at from a distance of 50 yards by Nordenfeldt 3-pdr. and 6-pdr. rapid-fire guns. Six shots were fired in all, and it is stated that the holes closed up so completely that water with a head of 40 feet failed to find its way through. Very small marks were visible on the woodite where the shots had entered, while large holes had been made in the backing. Four of the shots were fired to strike the target at right angles and two at an angle of 45°.

No Government tests of this material have ever been made.

TORPEDOES.

Late developments in torpedoes are in the direction of arrangements giving better directive power, and in a slight increase in size and weight, thus permitting the use of heavier charges.

A small size Howell torpedo was tried at Villefranche and a speed of from 22 to 24 knots obtained for a run of 400 yards.

It is reported that successful tests have been made in Germany with a torpedo made of paper containing a large charge of high explosive, and propelled and fired by electricity.

Occasionally a Whitehead is lost during torpedo practice. Several such losses from English men-of-war have occurred lately, in each case the torpedo having taken an erratic course after being discharged, and finally diving to the bottom.

The uncertainty as to the behavior of these torpedoes has led, in England, to experimenting with double torpedo tubes diverging toward the muzzle at an angle of 5°. It is intended that the torpedoes shall be discharged from these tubes in pairs, in the hope that if one misses the mark the other will not. The results of experiments thus far made do not seem to be very promising.

The objections urged against the use of nets for torpedo defense, except for vessels at anchor, are generally recognized as being well taken. For vessels at anchor a net defense, supplemented by booms at some little distance, is regarded as a fairly safe method for keeping a fish torpedo from exploding in contact with the vessel. In many trials against torpedo nets in use on vessels under way, the latest type of blunt-headed Whitehead has forced its way under the net with but little difficulty.

At the Paris Exposition last year the Hotchkiss Company exhibited a light buoy to be used in torpedo defense at night. Each buoy has attached to it two detachable floats filled with phosphide of calcium, one on each side, and also a compartment within itself filled with the same substance. The buoys are to be attached to a light wire rope which is to be kept a little below the surface by cork floats and to be anchored across threatened places. When the wire rope is struck by an enemy's boat the floats will be released from the buoy and the phosphide in both floats and buoy ignited, thus indicating the position of the enemy.

WHITEHEAD TORPEDO.

The United Service Gazette of November 2, 1889, contains the following information in regard to an improved type of this torpedo for use in the English Navy:

> A new pattern Whitehead torpedo has just been produced at the Royal Laboratory, Woolwich, which, it is claimed, is the best pattern yet brought out, and after exhaustive trials has been accepted as the service weapon of the future. It is slightly heavier than has been before used, and carries a heavier charge, but the important alteration is in the more delicate adjustment of the balance chamber and steering gear. Hitherto it has been always necessary to allow for a possible deviation of 4° on either side of the straight course of a discharged torpedo, and this has rendered it impossible to make a good shot, even at a long ship, at a greater range than 600 yards. Now the experts promise a reasonable certainty of hitting even a small boat at 900 yards.

Four hundred and seventy-eight Whitehead torpedoes were issued to the English naval service last year, and a still larger number of the recently adopted pattern are to be manufactured for issue this year.

The *Victoria*, during late trials, is reported to have lost a Whitehead of this new pattern.

WHITEHEAD UNDER-WATER BROADSIDE LAUNCHING APPARATUS.

This type of launching apparatus has been introduced by Mr. Whitehead for use in the broadside under-water discharge of the torpedoes bearing his name.

It consists of a torpedo-tube closed at its outer end by a sluice-door (Plate I) and either permanently set into the ship's side at any set angle or else fitted in with a ball-and-socket joint to admit of a certain degree of lateral train. This tube encases a sliding bronze shield of peculiar form which, by means of connections to a small compressed-air engine, can be made to slide in and out on rollers, worked by a ratchet and cogged wheel.

The shield (Plate II, Figs. 1 and 2) consists of a metal box much longer than the torpedo it is intended to contain. The forward side is curved (Plate III), and that part of it which is intended to be run out beyond the ship's side is pierced with two rows of rectangular spaces *a*, *a*, *a*, Fig. 1, which are fitted to be closed by doors connected to the locking-bolts *b*, *b*. These doors, *c*, *c*, Fig. 2, are pivoted somewhat like a balanced rudder, so that when unlocked the pressure of the water will tend to open them at once. The after part of the shield is cut away in a sloping form and is open for a distance a little greater than the length of the torpedo for which it is intended.

The shield is worked out and in by a small compressed-air engine connected with the tube, the exhaust from which is led into the space *d*, Fig. 2, between the outer end of the tube and a projection on the inner end of the shield, to act as a cushion in running out and thus prevent any shock as the shield reaches the end of its outer travel.

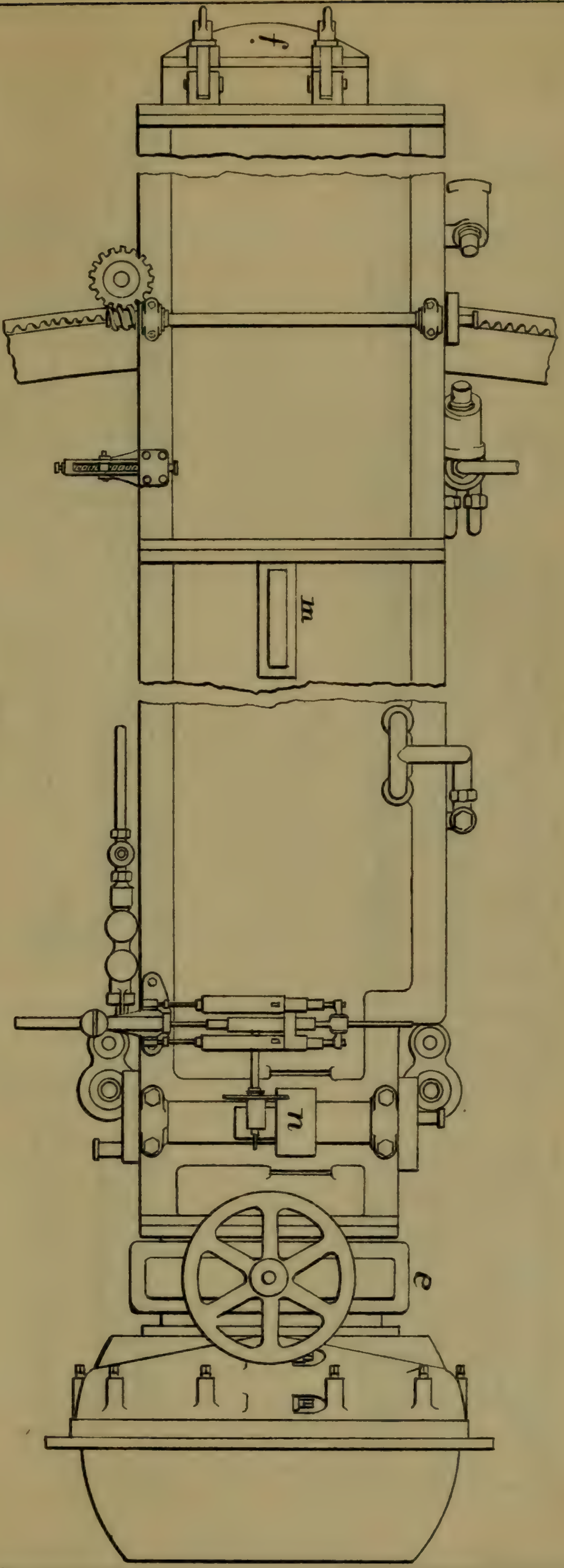
A sluice-door, *e*, Plate I, is fitted to the outer end of the tube to prevent the entrance of water to the casing before the torpedo is placed in the shield.

The following is the method employed in discharging a torpedo from this apparatus, the shield being in place within the tube and the sluice-door closed.

The hinged door, *f*, Plate I, at the breech of the tube, is opened and the torpedo pushed forward into the shield, bows first. As it goes in, a T-pin on its forward side is made to take and slide forward in the slotted bar *g*, Fig. 1, of the shield, thus preventing any sidewise or vertical movement of the torpedo. The torpedo is pushed in until it brings up against the stopper *h*, Fig. 2, which, until disengaged, prevents any additional forward movement. Then a strut *i*, Fig. 2, is pushed in against the rear of the torpedo, and prevents any movement to the rear. In this manner the torpedo is held firmly in place in the shield.

In case there is not sufficient room to introduce the torpedo through the hinged door *f*, it can be put in sidewise through a long door cut in the side of the tube.

PLATE I.



Plan

Whitehead Under Water Broadside Launching Tube.

PLATE II.

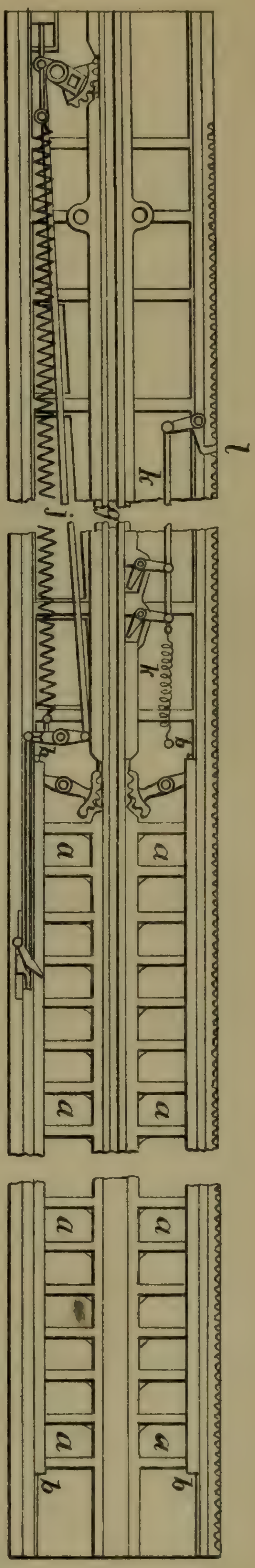


Fig. 1

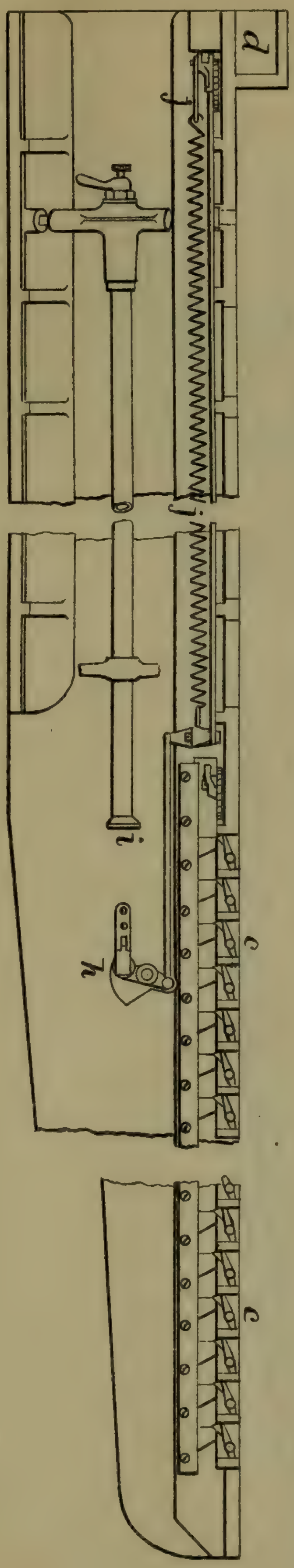
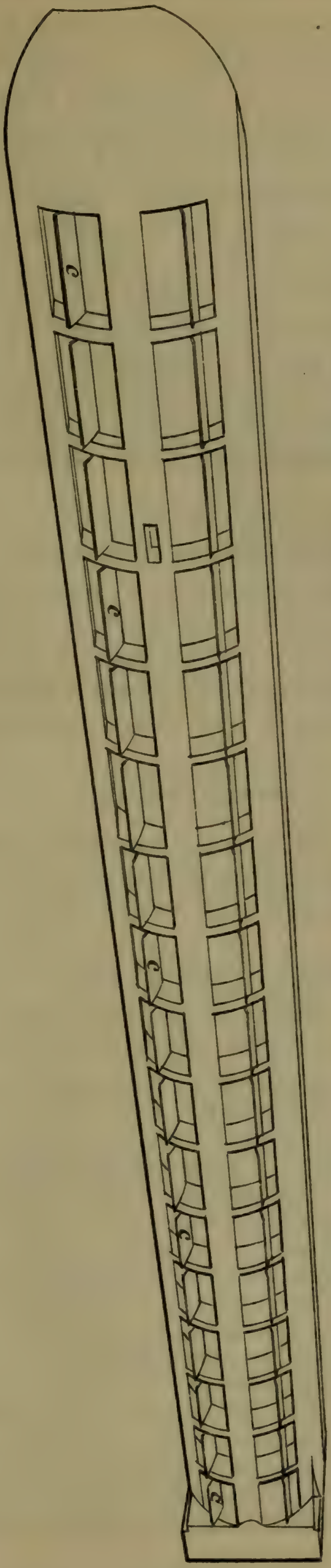


Fig. 2

PLATE III.



Forward View of Shield.

The locking-bolts *b*, *b*, the slotted bar *g*, and the stopper *h*, are all connected by means of a spring *j*, *j*, Figs. 1 and 2, to spring catches *k*, *k*, which are in connection with a toe, *l*.

The door *f* now being closed and sea-water admitted to the shield by the opening of the sluice-door *e*, the starting-valve of the air-engine is opened and the shield starts on its outward travel. As it starts, a trip-hook, *m*, Plate I, on the tube, pulls back the starting-lever of the torpedo engine and the torpedo propellers then commence to revolve. When the shield has nearly reached the end of its travel the projecting toe *l* catches under the pinion *n*, Plate I, of the driving-engine and withdraws the catches *k*, *k*; the spring, *j*, *j*, then pulls the stopper *h* away from the torpedo, frees the slotted bar *g* from the T-pin, and, by unlocking the bolts *b*, *b*, allows the doors *a*, *a*, *a*, to open to the water pressure.

The torpedo thus being entirely free from the shield, starts on its flight.

As the shield gets to the end of its travel, air-cushioning takes place, and an automatic attachment to the driving-engine causes it to reverse and to drive the shield back to its position within the tube.

When the torpedo is set free the shield-doors are all open and the inrushing water, exerting an equal lateral pressure along the entire length of the forward side of the torpedo, simply presses it directly sidewise aft, without deflecting it at an angle from the course given it when discharged.

BRENNAN TORPEDO.

This torpedo, which was described on p. 391, No. VII, has been much improved since, and is now said to have a speed of over 21 knots an hour for a range of nearly 2 miles. Its immersion can be regulated at will to a depth of 12 feet.

An interesting trial of this torpedo was carried out by its inventor in June last at Totland's Bay, Isle of Wight, of which the following account is taken from The Engineer of July 19, 1889.

The object against which the energy of the torpedo was to be directed was an old wooden hulk of about 300 or 400 tons, and 160 feet in length, thus presenting only about one-half of the frontage of a modern battle-ship or cruiser. It was towed along by a powerful tug at a speed of about 6 knots, and the tide running at about 5 knots brought up the total speed to about 11 knots per hour. When the hulk and tug were well underway in the channel they passed within about 1,300 yards of the torpedo station. But by the time that the torpedo itself was launched, and had approached and overhauled the moving target, which it did at a speed of about 21 knots per hour, the distance had increased to about 1,700 yards. Thus when the torpedo reached its victim it had run through a course of nearly a mile. It was charged with 300 pounds of blasting gelatine, and its movements were very clearly indicated by means of the flag at the summit of the little steel mast which rose perpendicularly from it, and cut the water into ripples as it proceeded. The friction of this steel mast against the water is said to reduce the speed of the torpedo by 3 knots. The course taken was not an absolutely direct one. The torpedo ran for about 250 yards close to the surface of the water so as to avoid the rocks and seaweed in the shallows. Then it dipped downwards and continued its course 10 feet below the surface, approaching the hulk but bearing a little away, so much so as to create an impression that it had gone astray. This however, was not the case, for the operator was only watching his opportunity, and directly he got alongside and within striking distance, he slacked one wire and rapidly hauled in the other, the torpedo darting in at once under the counter of the doomed vessel. A violent explosion was heard, and a vast volume of smoke arose, capped by a sheet of water which it had bodily lifted. Then the hulk pitched heavily forward, and slowly sank stern foremost, the water descending upon the floating débris.

TORPEDO-DIRECTOR.

This instrument is intended to indicate when a torpedo should be discharged and is in use on many foreign men-of-war and torpedo-boats.

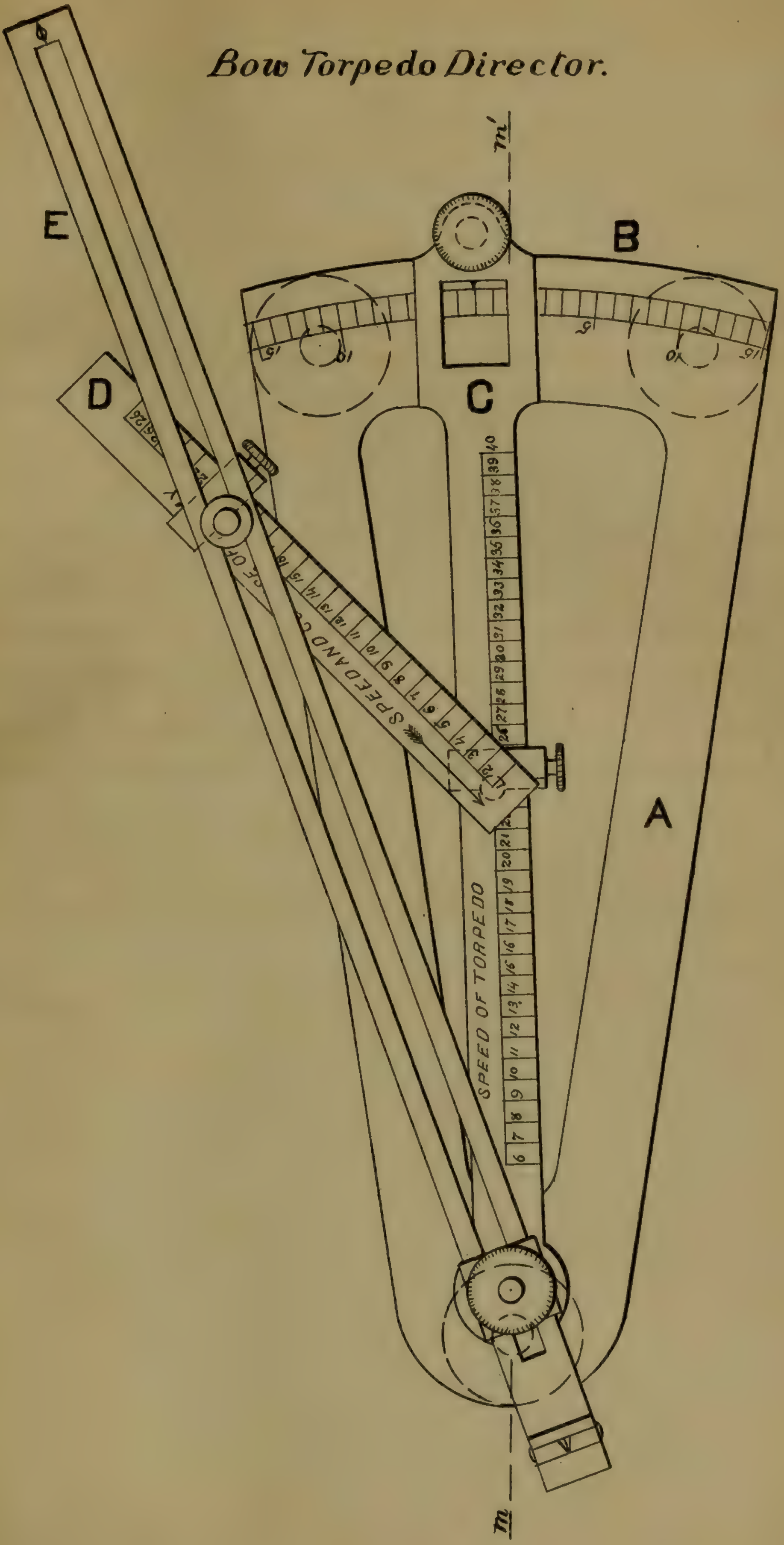
It consists of a metal sector, A, graduated to degrees on its circumference, and provided with three arms, C, D, and E. The arms C and E are pivoted at the center of the sector and the arm D is fitted to be clamped in any position on the arm C. The sighting-arm E is fitted to be clamped in any position on the arm D, and is provided with a sight-vane at its rear end and a sight-bar in front. The arms C and D are graduated to equal divisions to represent speed of torpedo and of enemy respectively.

To use this instrument with a bow torpedo: bring the radius m, m′, which passes through the zero of the arc B and the center of the sector, parallel to the fore-and-aft line and then clamp the arm C at an angle equal to that which the torpedo-tube makes with the fore-and-aft line. Clamp the arm D on the arm C at the figure representing the speed of the torpedo and set it for supposed course of the enemy. Then clamp the sighting-arm E on the arm D at the figure representing the estimated speed of the enemy. Wait until the enemy's vessel appears in line with the sights on the sighting-arm E and then discharge the torpedo.

In case the estimated speed and course of the enemy are correct, the torpedo and enemy, on the principle of similar triangles, should meet.

W. H. H. SOUTHERLAND,
Lieutenant, U. S. Navy.

Bow Torpedo Director.



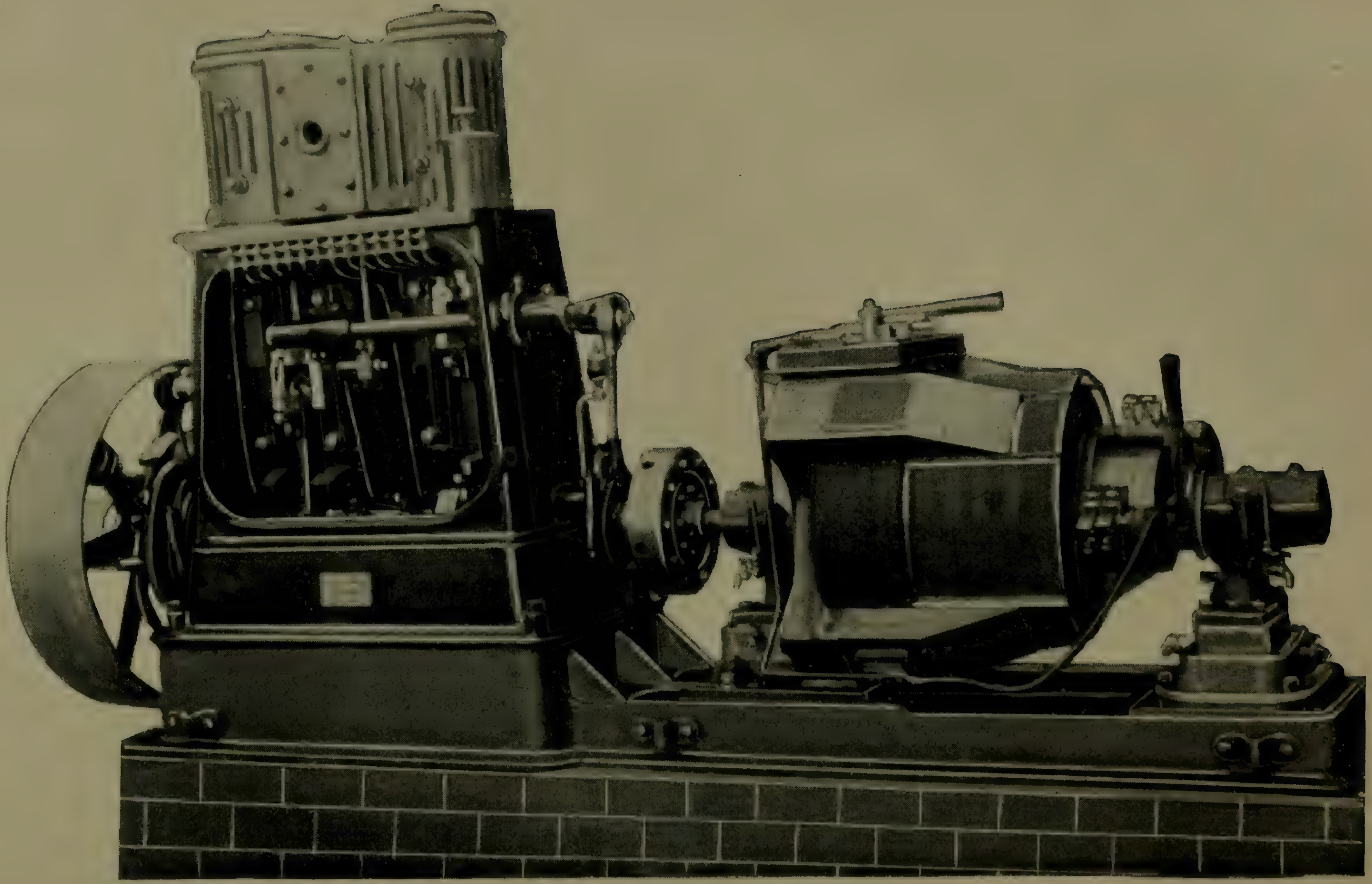


Fig. 1. Edison Multipolar Marine Dynamo coupled direct to Ball Compound Engine.

IV.

NOTES ON THE APPLICATIONS OF ELECTRICITY IN THE NAVY.

Though the past year has brought forth no radical changes in the practice of ship-lighting either in this country or abroad, and the types of dynamos of the year before have been adhered to, good work has been produced, tending toward the spreading of the benefits of the use of electricity on shipboard. The following table gives a résumé of the work done toward installing electric apparatus on our naval vessels during the past year. Figure 1 gives a view of a new combination of engine and dynamo for ship-lighting, using a Ball, high-speed compound engine.

This combination is designed for the *Concord* and *Bennington.*

List of vessels in which electric plants have been installed or contracted for since July 1, 1889.

Name.	State of work.	Contractors and remarks.
Yorktown	Completed	Edison Company, Thomson-Houston search lights put in by the Government.
Baltimore	do	Edison Company, Thomson-Houston search lights.
Charleston	do	Edison incandescent lights put in by the Union Iron Works, Thomson-Houston search lights.
Pensacola	do	Edison Company, no search lights.
San Francisco	Nearly completed	Edison incandescent and French search lights, all put in by Union Iron Works.
Petrel	Completed	Thomson-Houston, one French search light put in by Government.
Vesuvius	Contracted for	Thomson-Houston.
Vermont	do	E. S. Greeley & Co. provide material, put in by Government.
Miantonomoh	Being installed	Brush Company, Thomson-Houston search lights.
Philadelphia	do	Edison, Thomson-Houston search lights.
Concord	do	Edison, French search lights.
Bennington	do	Do.

We have now been using electricity for lighting purposes on shipboard during seven years and it may prove of interest to discuss those points in which this class of electric lighting differs from that on shore.

THE MARINE DYNAMO.

The important points in the consideration of a marine dynamo are:

First.—It should be direct driven. The reasons are obvious, as not only is the space taken up by the belting valuable, but in a sea-way the danger of running belts must be considered, especially when it is taken into account that naval vessels are fighting machines and the possibility of accident must be reduced to a minimum.

Second.—In should be compact. This is a natural extension of the above. Even now it is difficult to find room for all of the machinery, stores, and ammunition, besides providing room for berthing the crew on a modern man-of-war.

Third.—It should be free from liability to injury by salt water, and not too subject to mechanical damage.

In this respect there remains room for considerable improvement, the latest dynamos no better filling this requirement than did the old "L" machine in the Trenton in 1883, the first dynamo afloat in our Navy, and which ended its useful career in the great storm at Samoa last year, when it ran until the water had put out the fires under the boilers.

On board ship, salt water and damp air get everywhere, and within the last year a number of cases of slight burn-out have occurred in armatures, which, when installed, measured high in the hundreds of thousands of ohms insulation. The dynamo should not be easily harmed. The dynamo-room is now always low down in the ship, under the protective deck (if there is one), and when the light is not in use the room is very dark, rendering careful inspection difficult.

Fourth.—The dynamo should have small effect upon the compasses. This point has received little attention, though it is a matter of great importance, as the effect on many vessels is so great that, in order to work up the day's run, it is necessary to know the hours during which the dynamos have been in operation. Complete deviation tables are, therefore, necessary for the two cases. In different types of dynamos the effect with a 20 horse-power machine, at a distance of 12 feet, will vary from less than one-twentieth of the horizontal component of the earth's magnetism to several times the strength of the horizontal component. The latter is, unfortunately, rather the rule than the exception, and, in consequence, the position of the dynamo-room has to be well borne in mind in locating the standard compass.

Fifth.—It should be easy in running and require but little attention.

The machine should be non-sparking under constant load and also be able to stand sudden large changes of load with little sparking. This is necessitated by the fact that the dynamos now supplied for incandescent lighting are also used for search-light work and the conditions are aggravated by most of the search lights having hand regulation only. Thus, with a 200 ampère machine, not only are from 50 to 100 ampères thrown suddenly on and off, but, at the moment that the operator at the projector brings the carbons together, the dynamo is suddenly called upon to deliver over three-fourths of its total capacity.

Sixth.—It should be efficient and run cool, the former in order to avoid the waste of energy and a corresponding amount of the coal supply and also in order to avoid overheating. The dynamo-rooms on shipboard are at best warm, notwithstanding the motor fans, which are now usually supplied, and thus the safe limit of extra heating is reduced. At the same time consideration for the attendants requires that the cramped space be kept as cool as possible.

Seventh.—The dynamo should maintain a constant potential at all loads. This is, of course, accomplished by compounding, and, as there is only about 3 per cent. drop, it is usual to compound exactly or to only overcompound enough to allow for the decrease in the engine's speed with load.

Eighth.—The dynamo should be light. The reasons are obvious, but it is considered last, because usually a careful study of the materials and arrangement of the plant can accomplish more toward reducing the total weight than the strict adherence to a specification of watts per pound of dynamo. Thus, consider the difference between the weights of a 40 horse-power ship-plant on a 5 watts per pound specification and upon a 4-watts specification. Two 200-ampère, 80-volt dynamos, with their share of the bed-plates, will only weigh about 7,500 pounds. Twenty per cent. of this will be 1,500 pounds, an amount a large portion of which can really be saved in some cases by more careful attention to the amount of wire and moulding employed.

Naturally no one dynamo can best fill all of these conditions, and while the order in which they are above arranged will usually approximate to their relative importance, special cases arise which demand a re-arrangement. Thus, on torpedo-boats the most important quality is small size. With this in view numerous devices have been placed upon the market and faithfully tried, but none have, within the knowledge of the writer, proved satisfactory. The requirements of high efficiency, low speed, and low heating all give way in this class of dynamo to the necessity of compactness and light weight. Good results were hoped for from the Parsons turbo-electric generator, but experience at Newport demonstrated that the turbine was so inefficient for its consumption of steam as to place its use out of the question. There is as yet no apparatus to satisfactorily fill this want.

Up to the present, all of our ship plants contain one set or two or more similar sets, each composed of an engine and one direct-driven dynamo. The largest of these are of 200 ampères capacity; a very convenient unit, but one which can be doubled in capacity with advantage in ships which are not light below decks and which are likely to soon have extensive motor applications; for example, vessels of the monitor type.

INCANDESCENT LAMPS.

The incandescent lamps have given excellent results as to life from the very start, owing in great measure to the fact that low efficiency lamps are always used; nothing more economical than 4 watts per candle-power being usually required.

METHODS OF WIRING.

The two-wire system has always been used in the naval service, the ship never being allowed to form the return circuit.

In vessels generally three different methods of distribution on the two-wire system can be used. First, by mains running from the dynamo-room to the different parts of the ship and taking off taps from these mains; second, by running feeders forward, aft, and athwartships to the sides of the ship on the middle deck, and running risers up and down from these points, the risers being joined to distributing mains which run completely around each deck, and from which the taps are run to the fixtures; third, by running feeders to centers of distribution (say from four to eight feeders, depending upon the size of the vessel) and from their ends taking off all of the mains to the lamps, the feeding centers being joined by balance wires.

The first method has until now been universally used in our men-of-war, as it is a simple method and, by running mains on each side of the deck, a double illuminating supply is obtained, so that, if the main on one side is shot away or otherwise damaged, only half the lights would be put out. The second method is in general use in the merchant service, where it is usually given the preference. It gives a more even distribution of pressure at the lamps than the first, but is open to the objection for naval use that the lights of the different parts of the vessel are not so independent of each other. The third method, a modification of which has been adopted for the cruiser *Newark*, presents several points of advantage for the lighting of men-of-war. By its use all feeders can be kept below the protective deck, with the exception of the short vertical lengths necessary to reach to the several centers of distribution. Thus these main lines of supply will be better protected than they now are and, as an additional safeguard the "balance" wires, joining the feeding points, provide for supplying current to a feeding centre, even if its feeder should be broken. Each "balance" wire should contain a switch, which in time of peace would be always open (except in case of accident to a feeder). Thus the lower-deck lights, berth-deck lights, etc., could be turned off at the proper hours from the dynamo-room as at present, while, in time of action, with the switches in the "balance" wires closed, the illumination would be much more certain than now. From the feeding centres, distributing mains would be run each way—on both sides of the deck where desired—and from these the taps would be taken off to the lamps. This plan also decreases the amount of heavy, expensive wire and molding, the number of stuffing-box glands through water-tight bulk-heads, will produce a more regular light from hours of heavy to hours of light load and will conduce to longer life-time of the lamps. By properly disposing the feeder ends, it is an easy matter to obtain at the lamp terminals as little as one-fourth of the variation of electro-motive force that now exists, due to change of load on the circuit—and this with no increase of copper.

The switches in the "balance" wires are, of course, necessary in order to be able to control from the dynamo room the lights in the different parts of the ship. Should this plan of control be abandoned and the lights be controlled by switches at the feeding centers, closing the switches on the "balance" wires would produce a still better distribution of pressure.

MOTORS.

Motors have thus far been used only in driving small fans up to 1 horse-power, for hoists, and in one case a motor has been used for training one of the large guns—on board the *Chicago*. There are numerous small engines about a man-of-war, varying from 1 to 50 horse-power. Some of the smaller ones might even now be replaced with advantage by electric motors, but it must be proved in each case that the motor not only does the duty as well as the engine it replaces, but also that it and any increase necessary in the generating plant take up less room and weigh less than the engine and its piping. This, of course, will always be the case where very small engines are replaced, and as the tendency is to increase the capacity of the dynamo plant, it may not be long before motors may look for a larger field on board ship.

ELECTRICAL WELDING.

One electrical application that presents many advantages on board a man-of-war, especially when on a foreign station, is electrical welding. However, when it is introduced on shipboard the pressure of the generator should be reduced to 80 volts, in order that in case of emergency it might be used for lighting purposes, while the welders should have several sets of adjustable clamps. Welding-machines have not yet been actually used on shipboard, but it is to be hoped that their introduction is a development of the near future. They probably can not supplant any of the existing dynamos, owing to the necessity of motors, but must come in to occupy a place of their own, to almost entirely supplant the ship's forge and to add to the general useful equipment. The short description given below of an electrical welder and the generator necessary may assist to a clearer understanding of the subject by those who have not seen the process in operation.

ELECTRICAL WELDER OF 20,000 WATTS CAPACITY.

The principal of the operation of the machine is the heating of a point of contact between two masses of metal, due to the passage of an electric current across the surface of contact. The current used is alternating, in order to avoid the electrolysis that would take place in any other than an elementary metal and thus cause lack of homogeneity and consequent loss of strength at the point of junction. The alternating current is supplied by a converter, which forms the electrical part of the welder, the primary consisting of many turns of wire with a difference of potential at the terminals of about 300 volts, the secondary containing but one turn—a massive casting of bronze with a large superficial area to avoid the loss due to lack of penetration of the impulses of an alternating current into the interior of conducting masses. The difference of potential at the terminals of the secondary on open circuit is in the neighborhood of 1 volt, thus making the ratio of conversion in the neighborhood of 300 to 1. The core of this converter—like those used in the ordinary converter system for incandescent lighting—is built up of thin laminated strips of soft wrought iron, insulated with tissue paper. The terminals of the secondary are massive copper blocks, over which set copper sliding guide-blocks, mounted with steel clamps for securely holding the pieces to be welded. In the operation of welding, these are placed with the ends touching (they having been roughly formed slightly convex in order that they shall abut near their centres). The current is then turned on and as the metal becomes hot and finally soft at the contact, the contacts are approached by pressure applied by screw-winch, lever, or hydraulic power, until the whole cross-section is at welding heat and bulges as in ordinary butt-welding. The operation requires from a few seconds to two or three minutes, depending upon the size of the work. The burr is removed either by hammering while hot, or in the lathe when cooled. In no case does the heating extend to a perceptible degree more than about the diameter of the rod on either side of the weld. In case of working with easily oxidizable metals, borax is used as a flux.

The welder complete, including converter, clamps, and the necessary mechanical part (which in some forms of the apparatus is replaced by hydraulic machinery), is all contained in a substantial iron frame on a cast-iron base. In order to make the welder adjustable to different classes of work, it is necessary to be able to control the electro-motive force and therefore the electrical energy entering the primary. This is accomplished by placing a second converter (having a movable secondary) in series with the primary of the welder. On a segment of a split-ring laminated core, are wound several coils which may be connected in series or multiple by means of a switch. Within the annular ring is an iron armature, and mounted upon this is a heavy brass casting, inclosing the annular core and forming a secondary. If this be placed so that it embraces the primary coils, the drop in them will be

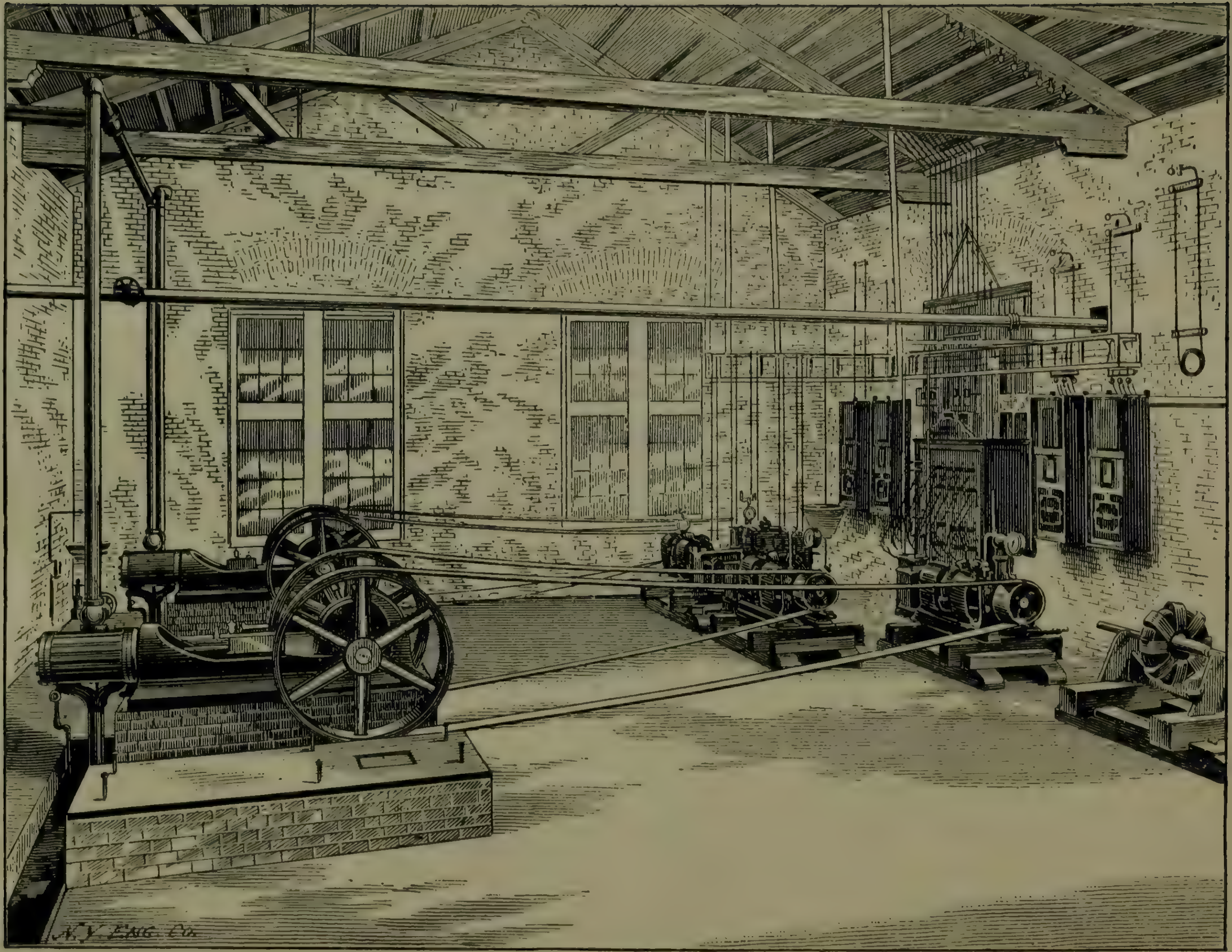
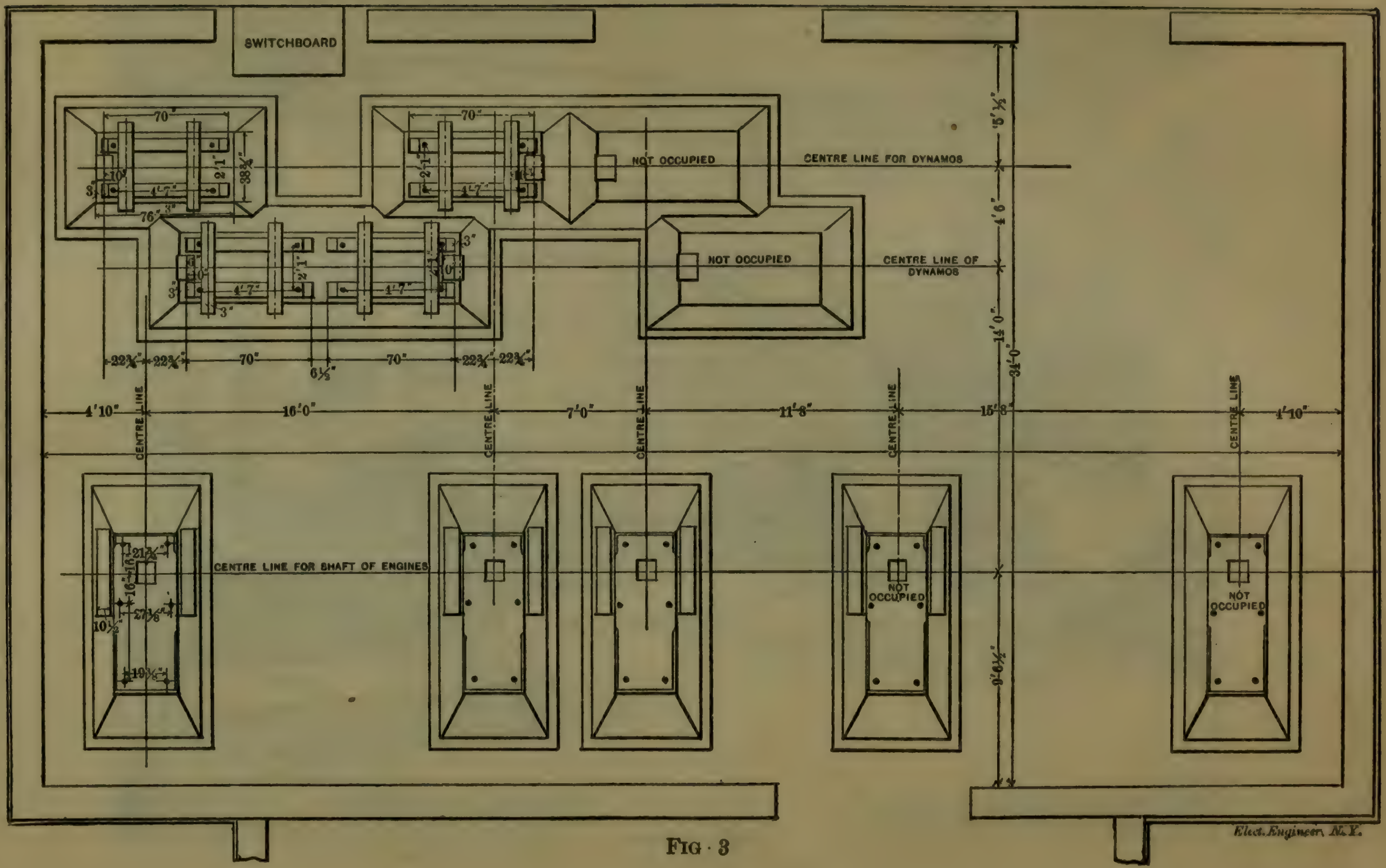


FIG. 2.



Elect. Engineer, N.Y.

FIG · 3

double (approximately) that which it would be in case the secondary is revolved to the other side of the ring, thus embracing the slit, across which practically no lines of force pass. Thus the E. M. F. absorbed in this throttling device may be varied within wide limits and vary in like proportion the E. M. F. available at the welder. The electrical capacity of this welder being 20,000 watts, the primary electro-motive force about 300 volts, that of the secondary, about 1 volt, the efficiency being in the neighborhood of 80 per cent., the current in the secondary at maximum work would be about 16,000 ampères. Thus the horse-power at the engine necessary for this size of welder (which can be used for welding wrought-iron bars 1¼ inches in diameter) is about 30.

It is stated by the electricians of the Thomson Welding Company that a weld in 2½-inch round bar-iron requires about 140 horse-power at the engine.

The fact that all parts of the apparatus remain remarkably cool indicates its excellent design. The dimensions of this machine are: Weight, 2,000 pounds; height, 34 inches; floor space, 27 by 7 inches.

The generator, as built for shore service, is a four-pole, high-speed, alternating dynamo, having an electro-motive force of about 350 volts. In one form of the dynamo, a portion of the current from the armature is rectified by a commutator and serves to energize the field, thus doing away with the separate exciter, usually necessary with an alternating current dynamo. The generator automatically maintains a constant potential at the point where the welders are to be used.

Of course, on board ship the generator would have to be direct driven, which need present no special difficulties, and output for output the generator would compare favorably in size with the dynamos now in use.

ELECTRICITY AT NAVAL SHORE STATIONS.

Below is given a short account of the arc-light plant recently installed at the Washington Navy-Yard, being the foundation for a complete electric lighting plant for that yard and the only one thus far installed at any of our naval stations.

THE ARC-LIGHT PLANT AT THE UNITED STATES NAVY-YARD, WASHINGTON, D. C.

This plant, the pioneer shore electric installation for lighting purposes in the Navy, has just been completed, the contract having been awarded to the Brush Electric Company last fall. Not only has advantage been taken of the most approved practices at the time of commencing work, but several novel features have been introduced with good effect.

In order to avoid the expense of additional boilers, the dynamo house was built adjoining the main boiler house, which supplies steam for the machine-shops surrounding it. The power plant comprises two Armington & Sims 10½ by 12-inch engines, each of which drives two Brush 30-light, 2000 c. p., arc dynamos. The general arrangement of the station is shown in the engraving, Fig. 2, and Fig. 3 shows a plan of the foundations.

Ninety-eight arc lights are installed; twenty for street and sea-wall lighting, and seventy-eight for lighting the machine-shops, forges, foundries, and station. All outside lights are double carbon; all inside lights, with the exception of those in the station, are single. All lamps were required to be automatic in action and to have their frames and casings insulated from the circuits.

The outside lines are run on dressed chestnut poles at a height of 25 feet from the ground. All of the wire used is that manufactured by the Bishop Gutta Percha Company, and was required to show an insulation of 1,000 megohms per nautical mile after an immersion of twenty-four hours. The lamp-posts, which are of iron, have two insulating joints of hard rubber. All inside wiring is run on glass insulators, except in the dynamo room, where porcelan knobs are used. Even here no concealed work has been allowed, and all wiring is in sight, being overhead.

Throughout all parts of the system every precaution has been taken to effectually guard against danger of shock and liability to fire. The dynamo-frames are laid on an inch bed of sulphur, to prevent the absorption of moisture from damp contact with the foundations; the holding-down bolts are capped with wood, and the commutators and brushes are covered with glass cases, only the wooden handles of the rocker clamps extending through slots in the sides of the cases.

The switch-board and all cut-out switches, one of which latter controls each building and each floor, contain no combustible material. The former is shown in Fig. 4, and the details in Fig. 5. The board is of marbleized slate, about 5 feet square, and has connections for six circuits and six dynamos, two of each being now blank. There is no metal on the front of the board, and the peculiar construction of the plugs shown in Fig. 5 renders impossible accidental contact with any metal in connection with the circuit.

Two long shops, containing heavy lathes and overhead traveling cranes, at first seemed to present a difficult field for lighting, but an excellent illumination has been obtained by suspending the lamps from iron outriggers, attached below the level of the cages to the pillars supporting the crane-tracks and about 18 feet from the floor. The lower halves of the glass lamp-globes for inside use are ground, in order to avoid shadows.

The following is a brief summary of the test made upon the plant by the writer for the Government before acceptance.

Engines.—Two Armington & Sims, single, non-condensing engines, 10½ by 12 inches, 275 revolutions; variation in speed between no load and full load, 2 per cent.

Dynamos.—Four Brush 30-lighters, 2,000 c. p.

Heating.

Dynamo.	Length of run.	Load.	Heating above atmospheric temperature.	
			Armature coils.	Field coils.
B	7½ hours	25 lights	48° F.	28° F.
C	do	do	56° F.	30° F.
E	6½ hours	29 lights	54° F.	44° F.
F	do	19 lights	44° F.	26° F.
E	2 hours additional	25 lights	56° F.	46° F.
F	do	do	46° F.	28° F.

Efficiency.—Efficiency test of E and F—driven from Engine No. 2.

A Taber steam-indicator was supplied by the Bureau of Steam Engineering, Navy Department.

The electrical instruments used were two Thomson astatic voltmetres and two Brush ammetres.

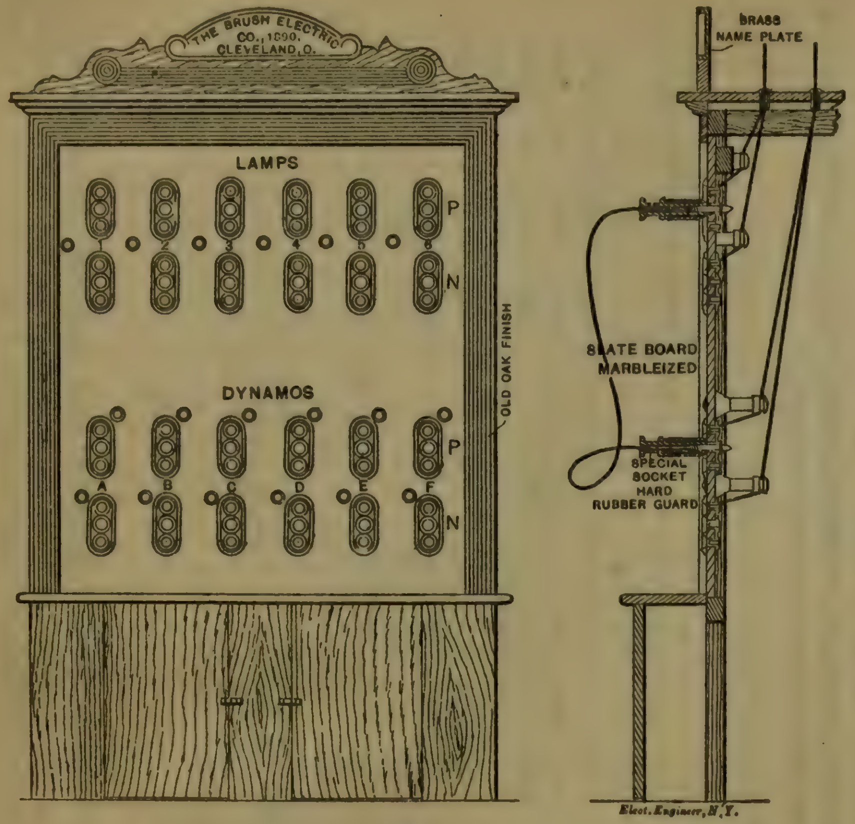

THE BRUSH ELECTRIC CO., 1890. CLEVELAND, O.
LAMPS
1
2
3
4
5
6
P
N
DYNAMOS
A
B
C
D
E
F
OLD OAK FINISH
BRASS NAME PLATE
SLATE BOARD MARBLEIZED
SPECIAL SOCKET HARD RUBBER GUARD
Elect. Engineer, N.Y.

FIG. 4

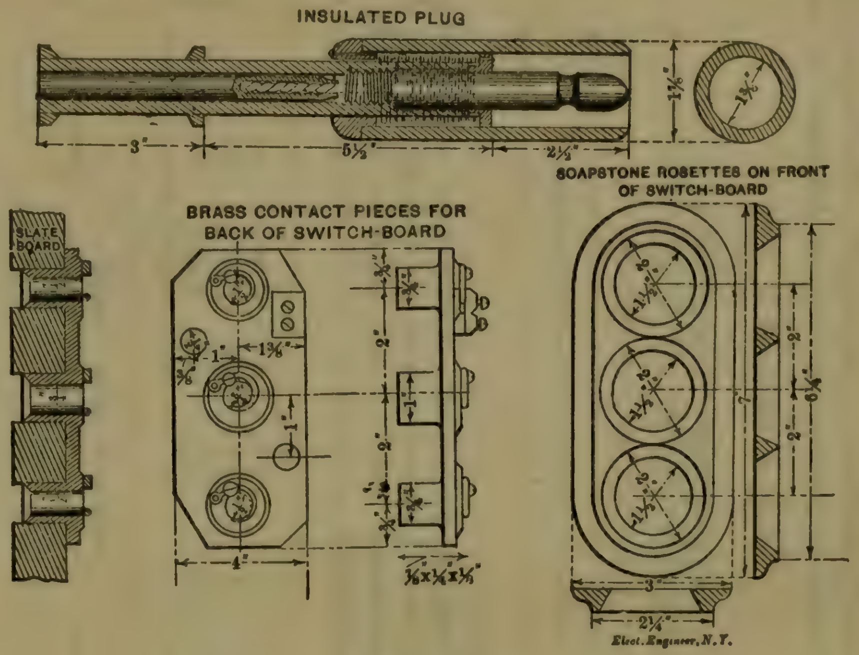

INSULATED PLUG
3"
5½"
2½"
1⅛"
SOAPSTONE ROSETTES ON FRONT OF SWITCH-BOARD
BRASS CONTACT PIECES FOR BACK OF SWITCH-BOARD
SLATE BOARD
1"
1⅜"
2"
4"
⅛x¼x1½"
7"
6½"
3"
2¼"
Elect. Engineer, N.Y.

FIG. 5.

The voltmetres were adjusted previous to the test and the ammetres were standardized. Ammetre E was 2 per cent. high, ammetre F 2½ per cent. high. Two readings of each instrument were taken to correspond with each card. The record is given below:

Efficiency test.

Number of card.	M. e. p. per card.	End.	Constant for 275 revolutions.	Revolutions.	Amperes.		Volts.	
					E	F	E	F
1	32.5	Front.	1.428	278	9.50	9.40	1290	1310
					9.45	9.35	1300	1210
2	32.5	..do ...			9.50	9.35	1310	1320
					9.45	9.30	1310	1330
3	35.5	Back..			9.55	9.30	1340	1320
					9.65	9.30	1400	350
4	35.2	..do ...			9.65	9.30	1410	340
					9.65	9.30	1420	340
5	13.2	..do ...			Friction of engine only.			
6	13.0	..do ...						
7	1.93	Front.		284				
8	1.30	.do ...						

The speed was taken at each card and was steady.

The above figures give as the commercial efficiency of the Brush 30-light (2,000 c. p.) dynamo a fraction over 84 per cent.

Insulation.—The insulation of the lines was as follows:

Number of circuit.	Class.	Number of cut-outs.	Number of lamps.	Length of wire in feet.	Insulation.
1	Outside........	1	25	10,000	Over 10 megohms.
2	Shops..........	1	25	5,000	Do.
3	....do	5	28	5,000	Do.
4	....do	2	19	5,000	Do.

When the tests were commenced the insulation of the dynamo circuits from the earth was a few hundred thousand ohms, probably owing to the fact that the machines had been standing unused several weeks in the new, damp building. After the runs necessary for testing—about 30 hours—the insulation rose to the following figures for the four dynamos:

B	ohms..	750,000
C	megohm..	1
E	ohms..	900,000
F	do...	600,000

It will be seen by reference to the diagram, Fig. 3, that ample space is left in the dynamo room to provide for future enlargement of the plant.

GENERAL REMARKS.

Good use is being made of motors for drilling purposes at the New York Navy-Yard, where several are in operation, and producing excellent results.

The electrical welding process will soon also add its usefulness to the equipment of some of the navy-yards, where there is much work that can be better accomplished by the electrical welder than by any other known means. Thus, the process of electrical welding renders possible the operations of welding cast-iron and of welding dissimilar metals to each other; gives us a means of repairing old boiler tubes and joining wire rope, and also accomplishes such operations as the welding of links in chains better than can be done in the smithy.

Every advance in electrical science seems to bring to light some new means for directly or indirectly increasing the efficiency of the man-of-war as a fighting machine, and each new extension of the use of electricity on shipboard adds to the comfort of both officers and crew.

GILBERT WILKES,
Ensign, U. S. N.

V.

THE NAVAL MANŒUVRES OF 1889.

By Lieut. **Charles C. Rogers**, U. S. Navy.

This narrative is based almost entirely upon press dispatches, as no detailed official reports have been published. In the main it is perhaps correct, the correspondents of the more noted journals having been professional men; but the sources were not always certain, and this fact should be remembered.

The account of operations on the English coast contains, substantially, extracts from a parliamentary return entitled "Narrative of the 1889 Manœuvres," which merely outlines very briefly the movements of the two fleets.

ENGLAND.

The object of the manœuvres was to obtain information on the following point:

What protection could be afforded to British interests in home waters when the British fleet adopts the policy of endeavoring to mask the fleet of the enemy from suitable strategic bases, keeping active watch over the vicinity of the enemy's ports, in which his forces are assembled, by means of scouts and cruisers; and on receiving intelligence that the hostile fleet, or any portion of it, had put to sea, instantly to detach a superior force to pursue and bring the enemy to action.

DISTRIBUTION OF INTELLIGENCE.

It was proposed also to test the value of a plan for establishing in London a central office for the receipt of all information relating to the movements of the enemy's vessels; to sift such information and to transmit any intelligence to selected stations for the guidance of the officers in command of the home squadrons. An office, under the Naval Intelligence Department, was established by the Admiralty for this purpose.

The map shows that Portsmouth, Sheerness, Hull, Leith, Greenock, Liverpool, Pembroke, and Devonport are naval centres, and that each is the centre of a group of signal stations called by its name. To illustrate the system for the diffusion of intelligence within any one group, one example will suffice. Let it be supposed that from the signal station on Flamborough Head a strange cruiser is seen, steering north. Flamborough Head is connected with the telegraph system, and the coastguard man at once goes to the telegraph-office with a special form, unknown to the public, on which his message is written. The telegraph clerk at once wires the news to the Admiralty in London; to Hull, the naval centre of the group; to Leith and Sheerness, naval centres north and south of him; and to the sixteen other stations in the group from Berwick on the north to Cromer on the south. At once, of course, the senior naval officer at Hull dispatches a cruiser in search of her, and those at Leith and Sheerness inform their cruisers of what has been seen.

The telegram is sent to the Admirality because the whole defense is worked from there; and, in this case also, because, if instead of a cruiser it had been a squadron that was seen, the Admirality knowing the whereabouts of the reserve British fleet, could at once order the east coast squadron to be re-enforced to the desired extent.

These arrangements increased enormously the power and mobility of the British fleet. There was no occasion for it to remain on the defensive at its base, or to fall back upon the channel for the defense of London.

The system proved most satisfactory, there being a general concurrence as to its efficiency and its absolute necessity in time of war.

GENERAL IDEA.

The following General Idea was adopted:

A strong maritime power, with whom hostilities are considered to be imminent, prepares a fleet in two of its principal naval ports.

A British force of superior strength is stationed in what are considered to be the most suitable strategic positions for masking the enemy's ports, in which his forces are assembled; and, in addition, small squadrons are placed in the most suitable positions on the coast for the purpose of patrolling and of affording protection against the attack of cruisers.

The British fleet is to be utilized by the admiral in command according to the best of his judgment (1) for the attack of the fleet of the enemy or any part of his forces should he leave his fortified ports; (2) for the protection of the coasts of Great Britain; (3) for the protection of British commerce in the channel and its vicinity.

RULES.

1. Should the opposing fleets, in whole or in part, sight each other at sea, the admiral or senior officer in command of each fleet or part of fleet shall endeaver to take such measures with regard to manœuvring as will enable him to engage the enemy with the greatest prospect of success. No gun is to be fired until the ships are within 4,000 yards by

day, or 2,000 yards by night, and no ship is to approach within 1,000 yards of an enemy's ship; on such occasions the umpires on both sides are to watch the proceedings with the greatest care, note the manœuvres performed, and award a decision as to the relative advantages gained. Should, however, one fleet or part of fleet prove to be, from the absence of some of the opposing ships or other causes, incontestably superior in power to the other, then, if the stronger force can maintain a position within 3 miles of the enemy for two hours, measured from the nearest battle-ships, this is to be considered as evidence of the ability of the superior force to bring on an action, and to have gained the advantage in the engagement; the ships of the superior force must, however, during this period be, in the opinion of the umpires, sufficiently well in hand to afford one another mutual support.

2. In considering the relative force of the battle-ships of A and B fleets, the official classification, as given in the navy-list, is to be adopted, except that the *Warspite*, *Shannon*, and *Northampton* are to be temporarily considered second-class battle-ships.

3. If two iron-clads, or one iron-clad and one protected vessel, can succeed in getting within a distance of not more than 3,000 yards from a single iron-clad, and be able to maintain such position for two hours, then the single iron-clad is to be considered to have been put out of action.

4. The same rule is to obtain in the case of a single iron-clad engaging a single protected or unprotected vessel, but in the first case the time is to be reduced to one hour, and in the second to half an hour.

5. If two protected vessels, or one protected and one unprotected vessel, engage one protected vessel, or two unprotected vessels engage one unprotected vessel, under the foregoing conditions, the single vessel will, in accordance with Rule 3, be considered to be put out of action.

6. If a vessel at anchor in an unfortified port, which is not defended by mines, can be approached by an enemy's vessel of equal or slightly inferior force, within a distance of 2,000 yards, by day or night, the vessel so caught at anchor is to be considered to have been rammed and put out of action.

7. Belted (armored) cruisers are to be considered, for the purpose of attack and defense, inferior to battle-ships, but superior to armed coast-defense vessels and protected vessels. Protected vessels are to be considered inferior to armed coast-defense vessels.

8. In actions between ships, guns are only to be fired at the commencement, when within the effective range at which fire is to be commenced, viz., 4,000 yards.

9. Any vessel which is exposed to an obviously overwhelming fire is to be considered out of action.

10. In the case of ships attacked by torpedo-boats, blank cartridge is to be fired from the quick-firing guns, machine guns, and rifles, but the heavier guns are not to be used.

11. Vessels which are claimed and admitted by the umpires to have been put out of action are to haul down their colors by day, and at night to hoist position lights. This is also to apply to torpedo-boats.

12. All vessels adjudged to have been put out of action are to follow the orders of the officer in command of the fleet, or part of the fleet, by which they have been put out of action.

13 If a ship is actually struck by a torpedo she is to be considered as temporarily disabled, and is to take no further part in the operations until the case has been investigated by the umpires and a decision is arrived at.

14. Telegraph wires are not to be injured during the manœuvres.

[NOTE.—Any obvious departure from what would be possible in war is to be dealt with on its merits by the umpire.]

ATTACK BY TORPEDO-BOATS.

1. Each torpedo-boat will be provided with two torpedoes fitted with safety heads. Torpedoes are not to be fired at a greater distance than 400 yards from the vessel attacked. Each torpedo-boat, when making an attack, is only to be allowed to fire one torpedo at a time, and, having fired it, she is to be considered out of action until she has picked it up and gone out of range of the ship to be attacked before recommencing the attack; after having fired both her torpedoes she is to be considered out of action until she has been supplied with others; on firing a torpedo a Holmes light is to be dropped.

2. Torpedo-boats attacking vessels will be considered to have been put out of action when they have been exposed to a continuous fire for two minutes within a distance of 2,000 yards from the vessel attacked.

3. If two torpedo-boats succeed in approaching within 400 yards of a hostile torpedo-boat, and can maintain such a position for ten minutes, the hostile boat is to be considered to have been put out of action.

CAPTURES.

In order to effect the capture of a British merchant vessel, one of the enemy's vessels must fulfill the following conditions:

1. (*a*) Maintain a position within one mile of her for half an hour. (*b*) Then stop for one hour, the total time, one and a half hours, being intended to represent the shortest time that would be required to overhaul a vessel, examine her papers, and either to put a prize-crew on board or destroy her.

2. Vessels especially engaged in the attack on British commerce are not to engage enemy's vessels except for the purpose of self-defense.

3. If an opposing vessel of superior force arrives within 4,000 yards of an enemy's vessel, whilst the latter is engaged in the capture of a merchantman, but before the capture has been completed, the enemy's vessel must sheer off and endeavor to escape.

4. In war, it will be necessary to board every vessel in order to verify

her nationality. A number of vessels would certainly not remain together in the presence of an enemy's cruiser, but would endeavor to escape; therefore only one vessel is to be captured at a time. A gun is to be fired by the vessel making the capture for each vessel which it is assumed has been captured.

In considering the award as to the validity of the claims made by any cruiser with regard to the number of captures made, the following points are to be carefully considered by the umpires: (*a*) whether the terms of paragraph 1 (*a* and *b*) have, in each case, been strictly carried out; (*b*) the number of hands which could have been spared by the cruiser to place prize crews in the vessels captured, without impairing her powers of offense and defense to an undue extent.

The under-mentioned table is to be considered the order of tne superiorty of the cruisers, observing that vessels bracketed are to be taken as equal in power.

1.	Mersey. Thames. Forth.
2.	Inconstant.
3.	Arethusa.
4.	Active. Volage.
5.	Calypso.
6.	Mercury. Iris.
7.	Ruby.
8.	Medea. Medusa. Magicienne. Marathon. Melpomene.
9.	Nymphe. Serpent. Tartar. Mohawk.
10.	Curlew
11.	Sharpshooter. Grasshopper. Sandfly. Spider. Rattlesnake.

DEFENDED AND UNDEFENDED PORTS.

1. The following are to be considered as defended ports, in which enemy's vessels are only liable to attack by torpedo-boats: Berehaven, Queenstown, Milford Haven, Plymouth, Portsmouth, Portland, and Sheerness. All other ports in Ireland and Great Britain are to be considered undefended ports, in which enemy's vessels are liable to all forms of attack.

2. B Fleet, or part of B Fleet, will be considered to have made a successful attack on a port, if the force employed remain eight consecutive hours of daylight within 5 miles of the entrance to the port without an equal or superior force arriving within two miles of him; and in covering or landing of troops, if the attacking force remains for twenty-four consecutive hours within 2 miles of the place selected for the landing of troops (which place must be suitable) without an equal or superior force arriving within 2 miles of him.

3. Vessels of B Fleet are free to use any of the ports in Ireland and vessels of A Fleet any port in England or Scotland.

CAPTURE OF COLLIERS.

Colliers are not to be liable to capture when proceeding with cargoes from Cardiff to Queenstown or Berehaven, or to Pembroke, or when returning empty to Cardiff to reload; under all other conditions they are liable to capture.

(*a*) If protected, after the capture of protectors.

(*b*) If unprotected, by any enemy's vessel or torpedo-boat.

The operations are to be confined within the following limits: On the north, 62° north latitude; on the east, 3° east longitude; on the south, 48° north latitude; on the west, 15° west longitude.

The following points are to be carefully considered by the admirals in command and finally settled before reporting to Admiralty that the organization of their fleets has been completed.

1. Private signals for enabling friendly vessels and torpedo-boats to be distinguished from hostile ones.

2. Special signals, near and distant, for day and night, which shall be unknown to the hostile fleets.

NOTE.—Signals to enable the coast-guard stations to distinguish friendly vessels from hostile ones will be supplied to each fleet.

THE MOBILIZATION.

Some results of the past work of the mobilization scheme were disclosed in assembling the fleet for the naval inspection of the 5th August, and the subsequent manœuvres. It was decided to commission for the latter 50 vessels, large and small, and 38 torpedo-boats. On the 18th July, 44 vessels and 38 torpedo-boats were put in commission. By the 23d, or within five days, the torpedo-boats and 39 vessels, starting from the several naval ports, had reached Spithead, where they were shortly after joined by the remainder, and where the Channel, First Reserve, and Training Squadrons also assembled. The fleet, thus formed, comprised 73 ships and gun-boats, and 38 torpedo-boats, with complements of more than 22,000 officers and men, of which the number mobilized amounted to nearly 16,000.

The personnel proved nearly adequate to the requirements. In several of the larger classes there were no deficiencies. The united engine-room complements of the mobilized ships amounted to more than 3,500; and when the fleets put to sea there were only 14 firemen of all ratings short. The signal staff was more deficient; but the establishment had not long been increased, and time, of course, was required to complete the recruiting of this staff up to the higher numbers decided upon.

During the two months previous to the review steps were taken to expedite as much as possible the arangements for the mobilization. Each ship's stores were sorted out and placed, separately, ready for shipment, coal was put on board and a few non-perishable articles, it being claimed that this was no more than should be done every year. After commissioning, a few days were devoted to the purpose of settling down; then steam trials took place, guns were tried, and the crews put through their various exercises.

Preparation for war in the new ships meant very little; but in ships like the *Hercules* the spars, sails, and running gear had to be sent down and stored away. It was found that getting rid of the top-hamper meant 1½ knots more speed for the ship, not to mention a large saving in fuel every hour.

In the opinion of experts, the results were satisfactory within the limits of the test. Mishaps occurred, but they would not have prevented the squadrons from proceeding to sea had they been ordered to do so.

Serious deficiencies were developed in the supply of officers of junior grades and of signalmen. There were frequent reports about the leaking of boiler-tubes. The Standard of July 25 states that numerous instances of deficiencies occurred in the provision of ordnance stores from guns and projectiles down to sights, fuzes, and tubes.

It should be said, however, that this operation was not a complete test of the mobilization scheme; the only sources drawn upon to man the ships were the home and harbor establishments. The harbor service ships were depleted of their crews and the training establishments of their staffs, but nothing was done to supply the vacancies. Owing to the expense attendant on calling them out, the Pensioner and Mercantile Reserves were not drawn upon. It is these sources, particularly the latter, that offer the greatest requirements and difficulties.

Admiral Colomb, in the Illustrated Naval and Military Magazine, September, 1889, says:

> The principal deficiency developed is that there are not enough officers in the reserves, and it would hardly be possible to tell them off to their ships in time to meet a real emergency. Most of the torpedo-boats were commanded by lieutenants, but nine were commanded by boatswains and gunners. A large number of lieutenants were lent from other ships to take their places in the mobilized fleet. The case is similar with the medical officers.

The value of the mobilization of the fleet in annually gauging how far the numbers on the active list are sufficient for the efficient manning of the fleet can not be overestimated.

COMPOSITION OF THE OPPOSING FORCES.

The manœuvres were to be carried out by two opposing sea-going fleets; one, supposed to be British, was to be designated the A Fleet; the other, supposed to be that of the enemy, was to be known as the B Fleet. The A Fleet was to be superior in vessels of all classes.

In addition to the A Fleet there were to be, on the side of the British, five squadrons. C Squadron, consisting of armored coast-defense vessels, gun-boats, and torpedo-boats, was to have its headquarters at Lamlash, and be under the orders of the admiral commanding the A Fleet. D Squadron was to have its headquarters at Plymouth, and be under the orders of the commander-in-chief at Devonport; it was to patrol from Dartmouth to Falmouth. E Squadron was to patrol from Dover to Cromer, with its headquarters in the Downs, and was to be under the orders of the commander-in-chief at the Nore. F Squadron, with headquarters at Hull, was to patrol from Cromer to the Tyne. G

Squadron, with headquarters at Leith, was to patrol from the Tyne to Aberdeen. Both F and G were to be under the orders of the commodore in command of the Regular Training Squadron, who, for purposes of manœuvres, was to consider Leith as his headquarters. The different sqadrons were not tied down to the exact patrolling limits indicated by the places above-mentioned, but were permitted to scout beyond them.

The defending force was far superior to that of the supposed enemy, and was disposed in such manner as to provide for local defense, while leaving the main British fleet free to operate in any direction threatened by the enemy.

BRITISH AND HOSTILE TERRITORY.

Great Britain was to represent British territory. Milford Haven was designated as the headquarters of the British sea-going fleet. Ireland was to represent the enemy's territory, his headquarters being Berehaven and Queenstown.

THE ARMY.

By order, the military forces were to assist in repelling the enemy if he came to close quarters. But, in reality, very little was done by this branch. On receipt of the message, which was also sent to a military center in each group, the troops were turned out and fell in in the barrack-yard. To do real service, they should have been on the coast; for all harm would have been done by the time they arrived from the depots.

The armored forts about Plymouth, some of which are of granite with iron shields at the embrasures, are built on hills, the earth of which has the bright red color so common in Devonshire; they are also surrounded by trees. These forts were painted red and green in such way that from the sea they were quite indistinguishable from the surrounding land and trees. The change greatly increased the difficulty of successful bombardment from a distance.

COAST GUARD AND POSTAL AUTHORITIES.

These branches were to assist in conveying intelligence to Admiral Tryon of the enemy's movements.

Certain spots were known to cruisers patrolling the coast, where, at any time, they could be sure of the latest intelligence. Along the south coast, for instance, Scilly, Falmouth, Torquay, and New Haven, are among such places, and, in the extreme north, Stornoway and Wick. The system in Ireland was the same as in Great Britain; there were twenty of these stations in Ireland and ninety-one in England, Scotland, and Wales.

The ships composing the forces on both sides are as follows:

I. THE ENEMY.

B FLEET.

[Headquarters: Queenstown and Berehaven.]

Vice-Admiral J. K. E. BAIRD, *in command; Rear-Admiral* ST. G. D'ARCY-IRVINE, *second in command.*

Ships.	Length.	Guns.	Tons.	H. P.	Sea speed.	Complement.
BATTLE SHIPS:	*Ft. In.*				*Knots.*	
Northumberland (*flag*)		29	10, 780	6, 560	11. 5	710
Anson (flag of second in command)		10	10, 600	11, 500	16. 8	536
Camperdown		10	10, 600	11, 500	16. 8	515
Collingwood		10	9, 500	9, 570	14. 6	459
Devastation		4	9, 330	6, 650	11. 8	285
Hero		6	6, 200	6, 000	13. 5	310
Inflexible		12	11, 880	8, 010	11. 5	460
Iron Duke		14	6, 010	3, 520	10. 5	482
Monarch		7	8, 320	7, 840	12. 8	572
ARMORED CRUISERS:						
Australia		12	5, 600	8, 500	18. 5	450
Immortalité		12	5, 600	8, 500	18. 5	450
PROTECTED CRUISERS:						
Arethusa		10	4, 300	5, 500	15	295
Calypso		16	2. 770	3, 720	11. 9	315
Curlew		4	950	1, 500	12	97
Magicienne		6	2, 950	9, 000	19. 8	193
Mersey		12	4, 050	6, 000	16	317
Nymphe		8	1, 140	2, 000	14. 5	136
UNPROTECTED CRUISER:						
Iris		13	3, 730	7, 330	16	276
TORPEDO VESSELS:						
Grasshopper		1	525	3, 000	17. 2	61
Rattlesnake		1	550	2, 700	17. 3	61
TORPEDO DEPOT VESSEL:						
Hecla		6	6, 400	2, 260	11. 7	272
TORPEDO-BOATS:						
No. 25	125 0			590	18	16
No. 41	125 0			690	18. 5	16
No. 42	125 0			690	18. 5	16
No. 49	125 0			720	18. 5	16
No. 50	125 0			770	18. 5	16
No. 78	125 1			720	18. 5	16
No. 79	128 8			900	20	16
No. 80	135 0			1, 540	21. 5	21

II. THE BRITISH.

A FLEET.

[Headquarters, Milford Haven.]

Vice-Admiral SIR G. TRYON, *in command; Rear-Admiral* R. E. TRACEY, *second in command.*

Ships.	Length.	Guns.	Tons.	H. P.	Sea speed.	Complement.
BATTLE SHIPS:	*Ft. in.*				*Knots.*	
Hercules (*flag*)	....	20	8, 680	6, 750	12. 5	388
Rodney (*flag of second in command*)	....	10	10, 300	11, 500	15.	500
Ajax	....	6	8, 660	6, 440	11.	292
Black Prince	....	28	9, 210	5, 770	10. 8	697
Conqueror	....	6	6, 200	6, 000	15. 5	335
Howe	....	10	10, 300	11, 500	16. 8	515
Invincible	....	16	6, 010	4, 839	11. 6	338
Neptune	....	6	9, 310	8, 000	12. 3	333
ARMORED CRUISERS:						
Northampton } Classed battle-ships for manœuvres.	....	12	7, 630	6, 070	11. 2	567
Shannon	....	9	5, 390	3, 370	10. 5	318
Warspite	....	10	8, 400	10, 000	15. 7	527
Aurora	....	12	5, 600	8, 500	18. 5	450
Galatea	....	12	5, 600	8, 500	18. 5	450
Narcissus	....	12	5, 600	8, 500	18. 5	450
Undaunted	....	12	5, 600	8, 500	18. 5	450
COAST DEFENSE VESSEL:						
Rupert	....	4	5, 440	4, 630	11. 5	197
PROTECTED CRUISERS:						
Forth	....	12	4, 050	5, 700	18	324
Marathon	....	6	2, 950	9, 000	19. 8	193
Medea	....	6	2, 800	9, 000	20	193
Melpomene	....	6	2, 950	9, 000	20	193
Mohawk	....	6	1, 770	3, 500	15. 3	157
Serpent	....	6	1, 770	4, 500	15. 6	157
Thames	....	12	4, 050	5, 700	15. 8	317
UNPROTECTED CRUISER:						
Mercury	....	13	3, 730	7, 290	15. 3	276
TORPEDO VESSELS:						
Sandfly	....	1	525	3, 000	17. 3	61
Spider	....	1	525	3, 000	17. 3	61
TORPEDO BOATS:						
No. 57	125 0	......	....	740	18. 5	16
No. 58	125 0	......	....	720	18. 5	16
No. 59	125 0	......	....	750	18. 5	16
No. 60	125 0	......	....	745	20	16
No. 66	125 4	......	....	630	20	16
No. 71	125 0	......	....	650	? 20	16
No. 75	125 0	......	....	680	? 20	16
No. 76	125 3	......	....	640	20	16
No. 77	125 0	......	....	660	? 20	16
No. 81	150 0	......	....	1, 330	16	26

II. THE BRITISH—Continued.

C SQUADRON.

[Headquarters, Lamlash.]

Ships.	Length.	Guns.	Tons.	H. P.	Sea speed.	Complement.
ARMORED COAST-DEFENSE VESSELS:	*Ft. in.*				*Knots.*	
Hotspur	....	4	4,010	3,060	10.5	180
Gorgon	....	4	3,560	1,670	11.1	191
Hecate	....	4	3,560	1,670	10.9	191
Cyclops	....	4	3,560	1,660	11	191
ARMORED CRUISER:						
Belleisle	....	4	4,870	3,200	12.2	256
PROTECTED CRUISER:						
Plover	....	6	755	1,200	13.3	75
SEA-GOING TUG:						
Hearty (as cruiser)	....	4	1,300	1,800	13	87
TORPEDO BOATS:						
No. 51	125 0	......	....	680	18.5	16
No. 52	125 0	......	....	720	18.5	16
No. 53	125 0	......	....	760	18.5	16
No. 54	125 0	......	....	720	18.5	16

D SQUADRON.

[Headquarters, Plymouth.]

COAST-DEFENSE VESSEL:						
Prince Albert	....	4	3,830	2,130	11.6	199
PROTECTED CRUISER:						
Racoon	....	6	1,770	4,500	15.6	157
UNPROTECTED CRUISER:						
Inconstant	....	16	5,780	7,360	14.3	614
TORPEDO BOATS:						
No. 2	86 0	......	....	400	18	11
No. 23	112 9	......	....	700	?20	14
No. 24	112 9	......	....	730	?20	14
No. 34	125 0	......	....	968	18.8	16
No. 45	125 0	......	....	690	18.5	16
No. 55	125 0	......	....	660	18.5	16

II. THE BRITISH—Continued.

E SQUADRON.

[Headquarters: The Downs.]

Ships.	Length.	Guns	Tons.	H. P.	Sea speed.	Complement.
COAST-DEFENSE VESSELS:	*Ft. in.*				*Knots.*	
Glatton	....	2	4,910	2,870	12.1	190
Hydra	....	4	3,560	1,470	11.2	191
GUN-VESSELS:						
Medway	....	3	363	310	9.7	51
Slaney	....	3	363	370	9.5	51
Trent	....	3	363	380	9.4	51
UNPROTECTED CRUISER:						
Volage	....	12	3,080	4,530	13.1	355
TORPEDO-BOATS:						
No. 4	86 0	......	....	350	18.4	11
No. 12	86 0	......	....	440	20.5	11
No. 63	125 0	......	....	700	20	16
No. 64	125 3	......	....	670	20	16
No. 65	125 0	......	....	640	20	16
No. 72	125 4	......	....	670	20	16

F SQUADRON.

[Headquarters: Hull.]

PROTECTED CRUISER:						
Tartar	....	6	1,770	3,500	17.3	159
UNPROTECTED CRUISER:						
Ruby	....	12	2,120	1,830	12.3	262
GUN-VESSEL:						
Medina	....	3	363	310	9.5	51
ARMED TUG:						
Traveller	....	2	700	1,210	12.1	23
TORPEDO-BOATS:						
No. 67	125 0	......	....	600	20	16
No. 68	125 0	......	....	650	?20	16

G SQUADRON.

[Headquarters: Leith.]

PROTECTED CRUISERS:						
Medusa	....	6	2,800	9,000	20	193
Pigmy	....	6	755	1,200	13.2	75
UNPROTECTED CRUISER:						
Active (Commodore)	....	12	3,080	4 130	15.1	356
GUN-VESSELS:						
Spey	....	3	363	410	10	51
Tees	....	3	363	320	9.6	51
Watchful	....	4	560	650	9.4	55
TORPEDO-BOATS:						
No. 73	125 0	......	....	900	?22	16
No. 74	125 0	......	....	700	?20	16

The five squadrons comprised armored coast defense ships of very respectable strength; but all they could do was to prevent cruisers from approaching too near. It is obvious they could not pursue them, nor could they venture far from their fortified base because of probable capture.

COALING ARRANGEMENTS.

It was decided that the manœuvres should be utilized to test arrangements for the supply of coal to fleets operating in home waters. A plan for the purchase, transport, and issue of coal to the forces engaged had been prepared by the Contract, Naval Stores, Transport, and Intelligence Departments of the Admiralty acting in combination. It was arranged that sufficient quantities should be sent to the headquarters of each fleet, division, and squadron, to permit the immediate completion, on arrival, of the stock on board every ship and torpedo-boat to full bunker-stowage, and also to provide for the earliest wants of vessels taking part in the operations. It was estimated that 40,500 tons of coal would be required; the quantity actually needed and supplied on requisition during the manœuvres was 38,749 tons, or within 1,750 tons of the estimate. In all, 27 vessels were employed as colliers. Several of them made more than one trip. A lieutenant was appointed to take charge of the coaling arrangements of each main fleet.

Press dispatches indicate that with the existing means the time, labor, and money expended produced altogether inadequate results.

To take in 30 tons of coal an hour is considered smart work. Two ships of the A Fleet worked up to this amount, but the rule was a much lower figure. The cruisers averaged 17 tons an hour; battle-ships like the *Rodney* and *Conqueror* averaged 24 tons, and the older iron-clads, like the *Hercules* and *Invincible*, a little over 25 tons an hour.

The means employed at Milford Haven were primitive; manual labor, with whips and derricks, and here and there a steam capstan, are hardly up to the requirements of a modern fleet; one collier to every three ships was brought alongside, then bags or baskets were filled from bulk and hauled in by sheer strength. Supposing the *Medea* short of 600 tons or the *Undaunted* wanting 800 tons, the former would take thirty-six hours or the latter nearly forty-eight, before getting away again. Yet, considering the time of anchoring, securing the collier alongside, getting the coal on board and going away again, Milford was as well off as Portsmouth or Plymouth; and at Portland the arrangement was still worse. The experience of the *Hercules* there may serve as a typical instance of what happened to coal before it reached the bunkers. It was first shoveled by hand out of the collier into a bucket, which was lifted by a hydraulic crane to a trolley running along the railway to the upper floor of a coal-store. Here it was capsized down a chute and landed on another trolley in the lower floor of the same store. Thence by a trap-door arrangement, it was dropped into a lighter of about 50 tons capacity. It was then towed to the side of the *Hercules*, where, being put into bags by the ship's company, it was hoisted on board and put in the bunkers. If the ship had been the *Medea* instead of the *Hercules*, the coal would have had to pass through *six* more operations of handling before it was actually burned. There are two tiers of bunkers in the M class; two-thirds of the coal is in the upper tier. When this class was steaming at full speed, it was even more difficult to get the coal from the bunkers to the furnaces than it was when coaling to get it from the collier to the bunkers.

The *Mersey*, for example, has no less than 29 separate bunkers, divided one from the other by water-tight bulk-heads. The vertical communication between the two tiers was infrequent and inconvenient. To pass the coal from the upper to the lower tier, it had to be carried some distance forward or aft to the chute between the two; and then an equal distance forward or aft along the lower tier in order to reach the only door through which it could be passed to the fire-room. In many cases it had to pass through a half-dozen water-tight doors in transit, every one of which should be closed before the ship goes into action. In that case the only way in which the coal could be gotten from the upper tier of bunkers to the furnaces would be by hoisting it upon deck, and then lowering it into the fire-room. In practice it was found quite impossible to feed the fires with sufficient rapidity to enable the ship to maintain her speed or to work her, with due regard for safety, when all the water-tight doors are closed. The fires being defective, a ship would have little chance to escape through speed.

Coaling in the B Fleet was done at the rate of from 25 to 30 tons an hour.

The best comment upon the system is perhaps that contained in the Explanatory Statement of the Naval Estimates for 1890–'91, which reads:

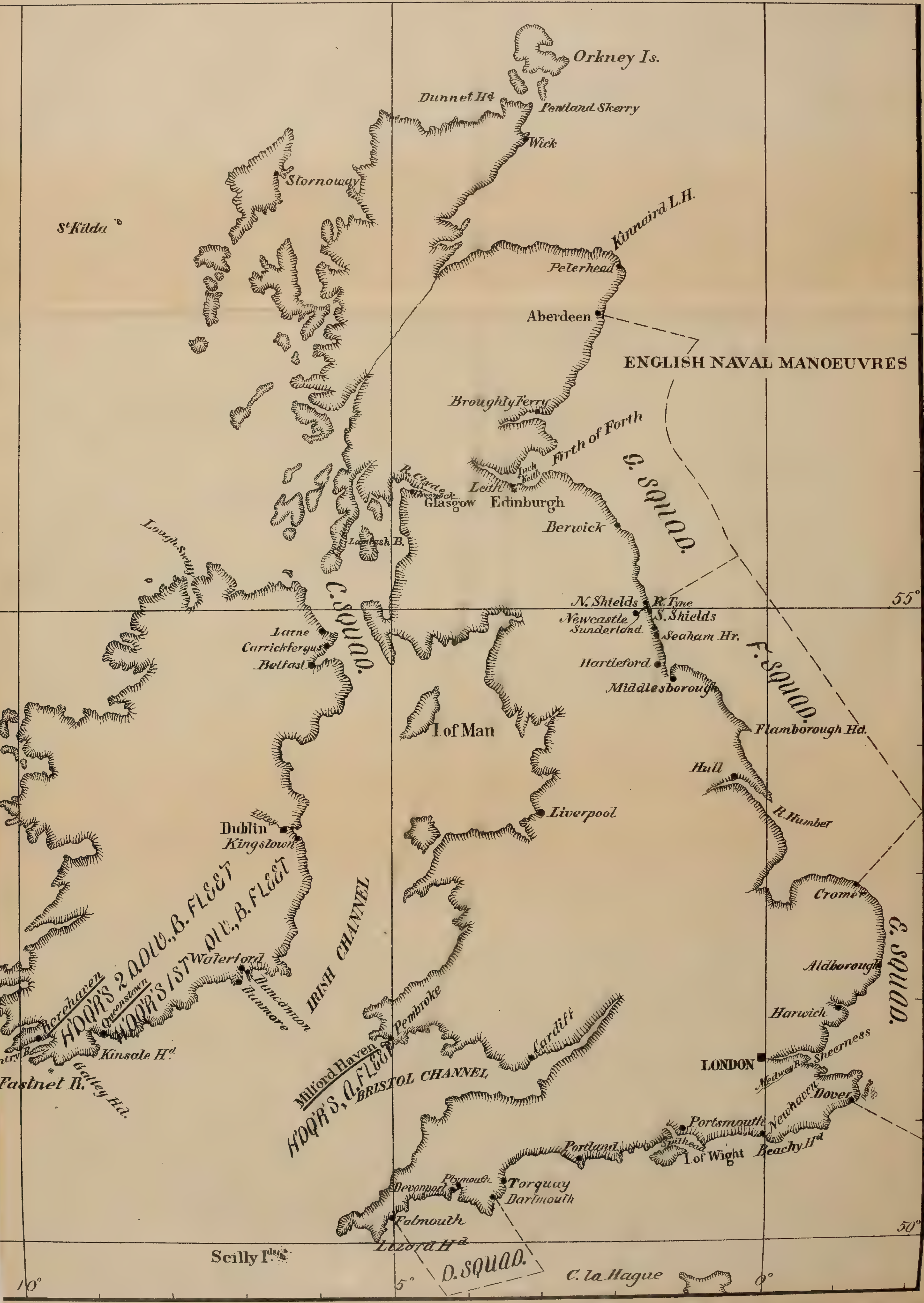
> These arrangements show a marked advance over those of the preceding year; and it may be fairly asserted that the problem of supplying coal to a fleet rapidly moving from place to place *has been partially solved.*

UMPIRES.

Four officers were to act as umpires, one being attached to each of the four flag-ships. They were—

(1) *With the A or British Fleet.*—Rear-Admiral Sir R. H. M. Molyneux, K. C. B., on board H. M. S. *Hercules*, flag-ship of Sir George Tryon, K. C. B.; Rear-Admiral Lord Charles Scott, C. B., on board H. M. S. *Rodney*, flag-ship of Rear-Admiral Tracey.

(2) *With the B or Enemy's Fleet.*—Rear-Admiral N. Bowden-Smith, on board H. M. S. *Northumberland*, flag-ship of Vice-Admiral Baird; Rear-Admiral G. D. Morant, on board H. M. S. *Anson*, flag-ship of Rear-Admiral D'Arcy-Irvine, C. B.



ENGLISH NAVAL MANOEUVRES

OPERATIONS.

INTRODUCTORY CRUISES.

The ships and torpedo-boats assembled at Spithead and were then inspected by His Royal Highness the Prince of Wales and His Imperial Majesty the German Emperor. On the 6th August they left their anchorage, the squadrons and torpedo-boats for their assigned posts, the fleets under orders to cruise separately for six days, practicing evolutions daily if the weather permitted. At the end of that period A Fleet was to proceed to Milford Haven, and B Fleet, its first division going to Queenstown and its second division to Berehaven. The fleets and squadrons were to complete with coal on arrival at their respective ports. By the 14th they had reached their several destinations and were ready to undertake the operations contemplated.

Hostilities were ordered to begin at 6 a. m. on the 15th August and to terminate at the same hour on the 29th.

POSITIONS OF THE OPPOSING FORCES AT THE OUTBREAK OF WAR.

The positions occupied by the various sections of the opposing forces on the outbreak of war were as follows:

The enemy had one division of his (B) fleet at Queenstown and the other at Berehaven. There was a British squadron at Lamlash, near the mouth of the Clyde. The main British or A Fleet was lying at Milford Haven. There was a squadron at each of the following points in Great Britain, viz, Plymouth Sound, the Downs, Hull, and Leith.

GENERAL DIVISIONS OF THE MANŒUVRING PERIOD.

The history of the manœuvres may follow the general divisions under which the various operations eventually ranged themselves. The main operations were divided into two distinct series: (1) the enemy's attempt to pass up the English Channel; (2) the campaign in the North Sea. The subsidiary operations consisted of (1) the coast attacks on Ireland; (2) defensive arrangements made by both sides at certain places; and (3) the proceedings of cruisers.

COAST ATTACKS BY A FLEET AND C SQUADRON.

Belfast.—In point of time the coast attacks carried out by a portion of A Fleet and by C Squadron came first. Directly the hour for beginning hostilities arrived, Captain Royce left Lamlash with C Squadron in the following order: *Gorgon*, *Belleisle*, *Hearty*, four torpedo-boats, *Cyclops*, *Hecate*, *Plover*, and *Hotspur*. His instructions from Sir George Tryon were to proceed at full speed to Larne, Carrickfergus, and Belfast, not to capture or hold the towns, but to destroy such resources in them as the enemy might be able to use for naval purposes. It was assumed that the latter proceeding would not occupy much time; therefore rapidity of movement was enjoined. The body of the squadron arrived off Belfast at 12.20 p. m., the *Belleisle*, *Hearty*, and torpedo-boats, which had been sent in advance, having reached the anchorage more than an hour before.

The fact was made known to the inhabitants of Belfast through the following letter, which was left by a naval officer at the city hall:

H. M. S. HERCULES,
At Milford, August 15, 1889.

SIR: War having regrettably broken loose, it becomes my duty to prevent any naval resources that are within reach of my adversary being used for the purpose of damaging those interests it is my duty to protect.

I desire to perform my task with as little inconvenience as possible to peaceful inhabitants, who take no active part in the war, and to protect private property that can not be turned to war purposes; but some loss and inconvenience are inseparable from the conditions of war.

I need not dwell further on this subject, beyond mentioning that it is not my present intention to interfere with civil authorities, or to advise them of any of their responsibilities, but I remind you that any irregular interference with my officers or men will be met at once with the severest punishment.

My advance squadron has directions which will be carried out as to the docks and shipping in port, and if the presence of the fleet is not more severely felt it is due to forbearance.

I have the honor to be, sir, your obedient servant,

G. TRYON,
Rear-Admiral, Commanding A Fleet.

His Worship, the MAYOR OF BELFAST.

At 1 p. m., the *Hecate*, and torpedo boats Nos. 52 and 53, were sent to Greenock, their station during the manoeuvres, to arrange for the defense of the Clyde; and at 2.15 p. m., the rest of the squadron, having executed the orders under which it had been acting, quitted the waters of Belfast.

That evening the following communication was received by post at the City Hall, Belfast, by the mayor's private secretary:

H. M. S. HOTSPUR,
Belfast Lough, August 15, 1889.

SIR: With reference to the letter from Rear-Admiral Tryon, K. C. B., Commanding A Fleet, which has been delivered to you by an officer commanding one of the cruisers of the advance squadron under my command, I have the honor to acquaint you that the destruction of the docks and shipping therein indicated is to be considered as having been carried out, and that I am now proceeding to sea.

I have the honor to be, sir, your obedient servant,

HARVEY ROYCE,
Captain and Senior Officer,
Advance Squadron, A Fleet.

His Worship, the MAYOR OF BELFAST.

At night the *Gorgon* joined the two torpedo-boats in the Clyde; the *Cyclops* and two torpedo-boats appeared off Liverpool, which was also protected by submarine mines; and the other vessels of the squadron cruised in St. George's Channel.

Waterford.—At 6 a. m. on the 15th, the hour at which C Squadron started from Lamlash, A Fleet stood out into the Irish Channel from Milford Haven. The weather was so thick that it was impossible to see more than a few hundred yards in any direction; but clear of the land the mist rolled away. A detachment consisting of the *Mercury* and five torpedo boats was directed to make for Kingstown and the Liffey. One division of the armored cruisers was dispatched at full speed to endeavor to get touch of the enemy's fleet, to capture his cruisers, and to protect commerce. The *Rodney*, *Howe*, and *Conqueror*, as the fastest battle-ships in A Fleet, were ordered to cover an advance on Waterford, made by a swift flotilla consisting of the *Warspite*, *Mohawk*, *Serpent*, *Sandfly*, and five torpedo boats. The older and slower ships, comprising the *Hercules*, *Invincible*, *Shannon*, *Ajax*, and *Neptune*, followed under the immediate orders of the Admiral himself.

Intelligence had reached the A Fleet that the *Nymphe* had left Queenstown in disguise, and it was surmised that she might have gone to the defense of Waterford.

In crossing the Irish Channel a rough sea was encountered. The *Howe*, however, ran 54 knots against it in four hours, the water breaking over her bows in great volume, and rushing aft to the forward barbette; the *Sandfly* rolled very deeply, while the torpedo-boats were bows under nearly all the time.

The fast battle-ships and the swift flotilla arrived off Dunmore at 12.40 p. m.; and within an hour they were joined by the *Hercules*, and the other vessels under Sir George Tryon. The captain of the *Warspite* sent an officer to notify the coast-guard station and the local authorities that Dunmore and all settlements within range of his guns were captured. The *Mohawk* and *Serpent* held the mouth of the river. The *Sandfly* and torpedo-boats Nos. 59, 71, 75, and 76, with No. 60 a mile ahead as reconnoitrer, proceeded up the river to Waterford to communicate with the authorities and destroy the shipping, the orders governing their action being similar to those given to C Squadron off Belfast. A sharp lookout was kept for any hostile force that might have anticipated this movement; and as the expedition reached Duncannon, a battery at the point opened fire on it. It was only a muzzle-loader, of old type, and before it could be loaded a second time torpedo-boat No. 60 slipped by it, only to be followed by a running fusillade of musketry from the men of an infantry batallion lining the parapets. By this time the *Sandfly* opened fire with a 4-inch B. L. R., which could be discharged at least six times while the shore battery was firing a single shot. Presently, too, the 3-pdr. Hotchkiss rapid-firing guns raked the enemy's parapets; and every torpedo-boat, as it passed, brought the fire of its Hotchkiss gun to bear on the fort and its garrison. By this time, too, the fort was receiving the fire of the heavy guns of the *Mohawk* and *Serpent*, which engaged it at a range of 3,500 yards, to cover the up-river movement.

During the passage up the river the *Sandfly's* crew under small arms were prepared to meet the rifle-fire of infantry, who might be concealed in fringes of woodland along the banks. On reaching Waterford, a few rounds were fired from the flotilla, which was followed by the surrender of the port with all its shipping and merchandise. At 3.30 p. m. the flotilla started on its return passage, during which it came a second time under the fire of Duncannon Fort. By 7 p. m. the whole detachment had retired from the Irish coast, steaming in two divisions, fast ships leading, with cruisers scouting on either bow. Running lights were carried by the guide vessels only. The sea was so rough that hatches were battened down and a torpedo boom on the starboard side of the *Howe* was broken and partly carried away.

Kingstown and the Liffey.—Simultaneously with the movements against Belfast and Waterford, the *Mercury* and torpedo-boats 81, 66, 58, and 77 advanced against Kingstown and the Liffey, the object, viz, the destruction of naval resources which might be utilized by the enemy, being the same as in the case of the detachments operating at Belfast and Waterford.

They arrived about 2 p. m.; the torpedo-boats stood well off, but the *Mercury* got in the cross-fire of two batteries near Kingstown and had to withdraw. The torpedo boats then made for the entrance of the Liffey, stole swiftly past the Pigeon-house Fort and up the river to Dublin custom-house, where they destroyed the shipping and went again to sea at a speed of nearly 20 knots an hour, blowing up a merchant steamer on the way out and running the fire of Pigeon-house Fort, which they returned. The result of this particular expedition, claims and counter claims having been put forward by the opposing sides, was submitted to investigation at the hands of the commander-in-chief at Devonport after the termination of the manœuvres. The final decision was, that before Kingstown the *Mercury* had not been successful; and, as regards the torpedo boats, that they had succeeded in passing up the Liffey unmolested, but that, on returning, the fire to which they were exposed from the guns of Pigeon-house Fort and also from the coast-guard might be reasonably supposed to have damaged some of them.

LOCAL DEFENSIVE ARRANGEMENTS ON BOTH SIDES.

Like the A Fleet, both divisions of the B Fleet also put to sea as soon as the hour for commencing hostilities arrived. Instead, however, of immediately following the movements of either force, it will be more convenient to give first an account of the steps which each side took to put important ports in a state of defense, or to add to defenses already assumed to be in existence.

On the side of A the *Rupert* was dispatched from Milford, with men and apparatus complete, to establish a system of mine defense, with a battery to protect it, at Falmouth. The latter consisted of four guns, so placed as to defend both the mines and the coast-guard station.

At the conclusion of the movement against the Irish ports already described, a squadron of observation, formed of vessels in part belonging to C Squadron and in part to A Fleet, and including the *Belleisle*, *Mercury*, *Plover*, *Sandfly*, and torpedo-boats 81, 66, 58, 77, and 57, was charged with the duty of protecting the St. George's Channel. It established its headquarters at Milford Haven. The *Gorgon* and *Cyclops*, with torpedo-boats 51 and 54, went to Liverpool, where they arrived on the 16th August, and made arrangements for the defense of the Mersey. The *Hecate* and torpedo-boats 52 and 53 proceeded to the Clyde, direct from Belfast, and arranged as necessary for the defense of the river. The idea evidently was that these vessels, being inferior to battle-ships, were more useful behind mines than in front of them, and that the mine defense thus protected would delay, at least, any intended attack.

To complete the account of the British local defensive preparations, it may be mentioned here that the squadrons D, E, F, and G began active patrolling movements as soon as war was declared.

The vessels of D Squadron were disguised. The *Prince Albert* was transformed to resemble a collier, while the *Racoon* was altered to look like a yacht. Top-masts were housed on the *Inconstant*. They, with the torpedo-boats, cruised between the Lizard and Dartmouth; the latter made Falmouth and Plymouth their headquarters, where during bad weather they generally moored at night.

Admiral Lethbridge, who directed the operations of E Squadron from Sheerness, disposed of his force so as to oppose the enemy should he seek to reach the Nore by steaming up the North Sea or through the Downs from the English Channel. The *Glatton*, *Hydra*, *Slaney*, *Trent*, *Medway*, and three torpedo-boats were stationed in the estuary of the Thames for the defense of London. The *Volage* and two torpedo-boats cruised as far as Harwich to watch and guard the north entrance to the channel. During the day the *Glatton* and *Hydra* occasionally reconnoitered down channel, and the gun vessels went over toward the French coast. All these vessels returned to their anchorage in the Thames at night. The numbers on the torpedo-boats were painted out. One of these boats was kept in the Downs at night to await dispatches from shore and carry them where necessary. The duty of guarding the channel at night was performed chiefly by the torpedo-boats acting as scouts, the coast-guard being also relied upon to a considerable extent to telegraph the approach of a vessel of suspicious character.

D and E did not come at any time into actual contact with the enemy. As will be seen, however, F and G did find him eventually within the area of their cruising ground; and the mine defense, established at Broughty Ferry, afforded shelter to some of G's vessels, as did the defenses of the Tyne to some of F's, when compelled to retire before a superior hostile force.

On the side of the enemy, the Admiral of B Fleet dispatched the *Nymphe* to Berehaven, which had been appointed as a coaling base for cruisers, to arrange a system of defense for the colliers there assembled. This vessel was disguised as a collier. In the execution of this duty the *Nymphe* was joined on the 23d by the *Calypso*, which had been employed at first in cruising off the mouth of the English Channel. On the 17th, the *Inflexible*, *Hecla*, *Grasshopper* and the B torpedo-boats arrived in Loughswilly to establish a base of operations for torpedo-boats. It was very shortly rendered impregnable against attack from heavy ships by the laying down of two extensive groups of mines in suitable positions and protected by quick firing guns. Thus a fortified port was extemporized in the north of Ireland, and was intended to be used for the double purpose of a harbor of refuge for the cruisers or other ships of B Fleet, and also as a base of operations for the torpedo-boats, which it was intended should raid on the Lamlash Squadron, the Clyde, and perhaps Liverpool. The very stormy weather, however, which continued without intermission until the end of the war, entirely forbade any action by the torpedo-boats; and as it seemed probable that the British had received full information as to the impregnability of Loughswilly, and had no intention of attacking it, the *Inflexible*, at a later date, was ordered into the North Sea and given a free hand to raid the towns on the East.

FIRST SERIES OF MAIN OPERATIONS.

As already observed, both A and B Fleets proceeded to sea as soon as hostilities began. Some portions of the former and C Squadron were employed in the previously mentioned movements against the Irish ports. A's armored cruisers, the *Undaunted*, *Narcissus*, *Galatea*, and *Aurora* reconnoitered Queenstown and Berehaven and learned, at the former place from a fishing boat, at the latter from observation, that B Fleet was no longer in either port. The *Forth* and *Thames* were sent towards the French coast in order to impede the attempts of these cruisers to injure British commerce, a duty which, as above stated, the armored cruisers were also to undertake.

The vessels of A Fleet, after withdrawing from the Irish coast, steered during the night of the 15th for the entrance to the English Channel. At 2.30 the next morning, the *Howe*, in closing up on the *Rodney*, was almost run down by another ship, which shot across her bows and then back again, passing within 40 yards of the ram. Day came in with fog, rain, and a heavy sea, so that it was difficult to see beyond 50 yards. But by the afternoon the weather had cleared somewhat; and at night the vessels of the fleet practically formed three lines across the English Channel, between the Lizard and Ushant and Portland and The Hague, maintaining a strict watch over the channel, and, at the same time, well within supporting distance of each other.

It was intended that the ships should arrive independently, but owing to the dense fog, which detained some of them, all, including those which had proceeded to Waterford, reached their appointed stations at the same time. The *Thames* and *Forth* were close to the French shore; the *Rodney*, *Howe*, *Conqueror*, and *Warspite*, farther out; and then, at intervals, the slower ships and smaller cruisers, the *Hercules*, flag-ship, being 20 miles south of the Lizard.

D Squadron, under the orders of the comander-in-chief at Devonport, with whom the admiral of A Fleet had opened communications, also shared in the work of guarding the channel on another line.

Vice-Admiral Baird, on leaving Queenstown, was accompanied by the *Northumberland* (flag), *Camperdown*, *Iron Duke*, *Hero*, *Inflexible*, *Immortalité*, *Iris*, *Mersey*, *Magicienne*, *Hecla*, *Curlew*, *Rattlesnake*, and torpedo-boats 80, 78, 50, 49, 41, and 25.

Two torpedo-boats, 42 and 79, were ordered to proceed by the east coast to Lough Swilly, for which place the *Inflexible*, *Hecla*, and *Grasshopper*, and the other torpedo-boats (as previously mentioned) were also directed to make.

During the 15th August, the first day of the manœuvres, the weather off the southwest coast of Ireland had been thick. In the evening it cleared, and the vice-admiral was joined, at a redezvous 30 miles southwest of Galley Head, by the second division of his fleet under the rear-admiral, who had left Berehaven in the morning. The *Arethusa* and *Calypso* were sent to cruise for merchant ships off Ushant. For a like purpose, the *Mersey*, *Iris*, and *Magicienne* were directed to cruise off the southwest and northwest coast of Ireland. Some changes in the cruising arrangements, which will be noticed in due course, were made later.

B'S ATTEMPT ON ENGLISH CHANNEL.

At 6.40 p. m., Rear-Admiral D'Arcy-Irvine was detached with the following force:

First Division: *Anson* (flag), *Collingwood*, *Australia*.

Second Division: *Camperdown*, *Hero*, *Immortalité*.

The plan of operations which the rear-admiral was directed to execute had been explained minutely in a memorandum drawn up for the guidance of the commanding officers of these vessels. Each division steered till dark a misleading course, the first making for a point about 20 miles to the southward and westward of the Fastnet, and the second for a point about 12 miles south of Galley Head. They were to arrive in this region by midnight of the 15th, and then the several ships were to proceed up channel on individual and parallel tracks, but not abreast of each other, to a rendezvous south of Beachy Head, there to form a squadron under the rear-admiral, and at once proceed to attack the Downs or E Squadron on the afternoon of the 18th. This being accomplished, the Thames was to be captured on the following day and the principal towns and ports on the east coast of Great Britain taken in detail; after which, going round the north of Scotland, the squadron was to rendezvous at Lough Swilly to complete with coal; and where, as already stated, a defended base had been formed with a view of operations against the C Squadron and Liverpool.

A collier for the service of the ships on the return voyage was sent to the Orkneys. The presence of this collier in Longhope, in the Orkneys, became known later to the Coast Guard, by whom it was reported by telegraph to the Admiralty. Intelligence that an attempt to capture the collier should be made was sent thence to the *Medusa*, which ship eventually effected her capture.

Instead of ordering his ships to proceed with all speed to the rendezvous and to steam especially fast when darkness lent a certain measure of cover to their movements, Admiral Baird directed a low speed to be maintained. His reasons for this and the entire plan of operations are best explained in an extract from his memorandum to the B Fleet at a later date, as follows:

> It will be seen that, instead of at once rushing to the attack on the first position, as on first thought one would be inclined to do, there was a period of considerable delay, forty-one hours. My reasons for this were that as the point (the Downs) was some 75 miles nearer the base of A Fleet than that of B Fleet, a race for this position would result in A Fleet being six hours ahead--of course assuming that the admiral of the defending force judged rightly as to where the attack would be made, and took measures accordingly by pushing on his fast battle-ships and belted cruisers, which were the only vessels that could, with success, be brought against my force of vessels of corresponding classes. From subsequent events, it appears that he did judge rightly as to my objective but did not hurry on his forces as I had expected. Having this in view, I decided not to attempt to rush on the position, but to give the defending fleet some considerable time to wait, thus throwing the enemy off his guard and probably being the means of deceiving him as to the point of attack. Again, it was advisable to make the attack in the evening, allowing time to crush an inferior force before dark or escape from a superior force into the North Sea, and in the darkness shake them off. This could only be done by proceeding at a slow pace from the coast of Ireland, and it was thought to be the best plan to pass the ships forming the detached squadron into the English Channel singly, on given tracks, generally about 10 miles apart and each ship's route made known to the whole, so that at any time, if necessary, they could combine for general action by entering the channel. In this manner the enemy would be deceived as to numbers if the ships were sighted by them, and the great speed of the ships would enable them to get away from any ordinary battle-ship. Narrow channels, where they were likely to be interrupted, were to be passed through at high speed. This being accomplished and the ships being formed into a squadron under the rear-admiral, the general programme was then to be carried out as circumstances permitted.

The movements of the *Hero* and her consorts, however, were reported by the fast cruisers of A Fleet to Admiral Tryon in time for him to send into the channel a force powerful enough to cope with and scatter the B Fleet.

The first conflict between the ships took place on the morning of the 17th of August, while the vessels were still cruising between the Lizard and Ushant. Between 5 and 6 o'clock the *Camperdown* sighted and subsequently engaged an A cruiser, which proved to be the *Thames*. The battle-ship claimed to have put the cruiser out of action, but in the final adjudication on claims, this contention was not regarded as established.

At 6.45 a. m., the *Howe* sighted the *Hero*, hull down, bearing southwest and over 7 miles distant. On reporting it to the *Rodney* (flag) Rear-Admiral Tracey signaled to chase. The flag-ship started in pursuit at full speed, together with the *Howe*, *Conqueror*, and *Neptune*. The *Hero* at once started ahead at full speed and shaped her course with a view of picking up one or more of her consorts. At 7.30 the rear-admiral made out the *Camperdown* and *Immortalité* of the B Fleet and his next signal was "Chase enemy." Each ship forged ahead at full speed, the *Rodney*, *Howe*, and *Conqueror* fairly burying their forward decks under water, large quantities of which went below. About three-quarters of an hour later, he sighted the *Warspite* and *Melpomene* of his own side in chase. At the time of being seen from the *Rodney*, the *Camperdown* observed her two friends, the *Hero* and *Immortalité* standing towards her and signaling that they had been chased by some of A's heavy ships and the *Warspite*. The three B ships now altered course to the westward, proceeding at a speed adapted to that of the *Hero*, which was the slowest.

The A ships continued to follow; the *Hero* was being rapidly over hauled; the other two but slightly. Meanwhile, other A ships were coming up, and at 8.50 the *Warspite*, together with the *Thames* and *Medea*, which until then had been at a long distance away from the *Rodney*, were only 5,000 yards off, and were coming up rapidly at full speed.

The *Medea* was signaled to return to Admiral Tryon with the news of the pursuit of the enemy. Then the second-class cruisers, *Melpomene* and *Marathon*, ranged up on the starboard quarter of the *Howe*, and in rear of the *Thames*, which was leading, and the *Warspite*. At the same moment, the haze having disappeared, the greater portion of the British fleet was seen 8 miles away, steaming at full speed to join in the chase. They were in line abreast, the *Hercules* on the right; then in successive order the *Undaunted*, *Invincible*, *Shannon*, *Black Prince*, *Northampton*, and *Mercury*. The *Hercules* signaled to continue the chase, and then she and her consorts gradually dropped behind till they were out of sight of the faster ships. They were doing their best, probably 10 to 11 knots, but the *Rodney* and *Howe* were going over 14, whilst the *Warspite* and cruisers could do better still. The B vessels now headed more to the westward, and the *Rodney* steered to get to windward and drive them—the *Hero*, at any rate—up channel.

At 9.50 the *Thames* was 4,000 yards off the starboard beam of the *Hero*, the maximum range for opening fire under the rules. The *Warspite* was nearing the *Hero*; and in nearly line abreast, 3,500 yards behind, were the *Rodney*, *Howe*, *Melpomene*, and *Marathon*, the last not far from the port quarter of the *Warspite*.

Signal was now made that the *Rodney* and *Warspite* should attack the *Camperdown*, while the *Howe* and the *Conqueror* were to engage the *Hero*; but the *Conqueror* was hull down from the *Howe*. At 10.20 the *Camperdown*, then far ahead of the *Hero*, altered her course six points to starboard and signaled that she had sighted the *Collingwood.* At that moment the *Howe* was coming up on the starboard quarter of the *Hero*, and the *Rodney* on her port quarter, while the *Warspite* and *Thames* were not very far away on her starboard beam. The *Camperdown's* signal, however, was only a ruse to deter her enemy. All that could be done now was to make a good fight of it; and at 10.30 a. m., being within engaging distance, fire was opened by the *Camperdown* and *Hero*, and shortly afterwards replied to by their opponents. Rear Admiral Tracey, having ascertained the strength of the enemy's force, sent back the *Neptune* and *Conqueror* to rejoin the commanding admiral's flag-ship. The *Rodney*, *Howe*, and cruisers then engaged the *Hero* and *Immortalité.* The *Hero* is designed to fight with a forward turret, bows on, and to ram, so that in retreat she is comparatively helpless. The captain of the *Howe* so manœuvred his ship that he could engage his adversary without exposing his own vessel to a single shot from the other's big guns. The *Hero* at first directed her attention to the *Warspite*, when the latter, assisted by the *Melpomene*, returned the fire.

The *Rodney* opened fire within 3,000 yards of the *Hero* at 11:10, a. m., and the *Howe* and *Thames* also joined more directly in the action, whilst the *Immortalité* sent back an answering fire from her battery. By 11.20 all the ships were engaged; the contest was too unequal for such vessels as the *Melpomene* and *Marathon*, so they were signaled to stand off. Steadily the *Rodney*, *Howe*, and *Warspite*, firing all the while, closed up. By 11.30 the *Warspite* was lying 1,000 yards distant from the starboard beam of the *Hero*, with the *Rodney* and *Howe* but 1,200 yards astern of her. Two minutes later the *Immortalité* stood to the southeast and the *Rodney* changed course to head her off. In obedience to an order, the *Warspite* stood across the *Hero's* bows, passing well ahead to join in chasing the *Immortalité*, which was some 3,000 yards away. The *Camperdown* was still farther off; then the *Thames* also crossed the *Hero's* bows, and a mistake, which might have lost the three enemy's vessels, was nearly committed on the side of A Fleet. When the *Rodney* and *Warspite* had stood well to the eastward, the *Camperdown*, thinking them quite out of the fight, so far as the *Hero* was concerned, put about. The two hours' limit necessary to effect a capture had not been reached, and the *Howe*, with any number of unarmored cruisers, was disqualified from coping single-handed with two battle-ships. The *Camperdown's* movement was a bold one, but her captain hesitated in carrying it out, hanging back and waiting, no doubt, till the *Rodney* and *Warspite* were clear away. From 11.40 to 12.30 the chase of the *Immortalité* went on, while the *Howe* still engaged the *Hero* and the *Camperdown.* About noon the *Camperdown* put on all steam and bore down to the *Hero*. The *Howe* dropped astern into a position which made it impossible for the *Camperdown* to fire without maiming her own consort. Then the *Camperdown* went to the eastward a little to bring her guns to bear on the *Howe*, but the *Rodney* noted the danger and put about. At 12.41 the *Camperdown* came charging full at the *Howe* and *Rodney*, bearing down within 1,000 yards of the former. The torpedo men on the *Camperdown* were at their stations, but the *Howe* had been before them at this game, launching at the *Hero*, and the *Camperdown* was certainly beyond the 400 yards' distance within which torpedoes must be launched.

At 12.50 the *Howe* received permission to devote her attention to the *Camperdown*, for the time limit was now up with the *Hero*. The *Howe* stood in closer to engage; the exact position of the battle-ships at the time was nearly mid-way between the Scilly Islands and Ushant. It was, of course, a running fight, the enemy heading over towards the French coast. At 1.05 p. m. the *Camperdown* rounded abreast of the *Hero*, 800 yards to port, and, reducing speed, kept her company, both ships firing away as hotly as ever. The position was not a favorable one for the enemy, for the *Howe*, lying to starboard of the *Hero*, was protected from the *Camperdown's* fire, while the *Rodney* was so placed on the port quarter of the *Camperdown* that she could rake either of the B battle-ships. For nearly a quarter of an hour longer the fight was waged between the four battle-ships. At 1.20 Rear-Admiral Scott, on the *Rodney*, signaled to the two B ships, "Umpire declares you out of action. Cease firing." The latter ran up flags, claiming that the time limit and conditions had not been fulfilled, but the umpire ordered them to take stations astern of the *Rodney*. The two prizes fell in behind her, the *Howe* following in their wake. The ships headed towards the Lizard and soon picked up the *Thames* and *Melpomene*; later on, the *Marathon* came with a message from Admiral Tryon for the *Howe* and *Rodney* to pursue the *Camperdown*. She was dispatched back with the news that both the *Hero* and *Camperdown* had been made prizes. About 4 p. m. the *Warspite* was made out, bearing up with the *Immortalité*, which she had captured. At sunset the Lizard was sighted, off which the division of the British squadron that took part in the action cruised all night. At daylight on the 18th the *Conqueror* and *Neptune* were seen off to the southward, slowly returning, whilst towards Falmouth the rest of the fleet, under Admiral Tryon, were cruising about.

At 9.30 a. m. Admiral Tracey took the three prizes, and leaving the *Howe* and *Warspite* off Falmouth with orders to start on a fresh cruise, proceeded to that port to join the commander-in-chief.

At the final adjudication the claim as against the *Camperdown* was not substantiated, though it was as against the *Hero*, and also as against the *Immortalité*, which had been overtaken and engaged by the *Warspite*. That the force with which the *Camperdown* and her consorts were engaged had gained the advantage, as anticipated by the rules, was not disputed.

The name of the *Camperdown*, on joining A Fleet, was changed temporarily to *Belfast*; that of the *Hero* to *Waterford*; and that of the *Im-*

mortalité to *Larne.* But they were to take no further part in the manœuvres.

In the mean time the B ships of the other divisions had also come in contact with those of A. At half past 6 in the morning of the same day, the 17th, Rear-Admiral D'Arcy-Irvine, in the *Anson*, whilst starting to the eastward, sighted five ships of the other side 10 miles off to the southeast. At first the rear-admiral shaped course so as to pass between the strangers and the Lizard, but fearing that he might be seen from the signal station and his movements be telegraphed all over the coast, he decided to run back along the track and pick up some of his own ships. The *Collingwood* was soon sighted and directed to stand to the northward and try to pick up friends, whilst the *Anson*, with the same object, stood to the southwest. The *Hero* was next observed being chased, and stretching across the *Anson's* track were seen the *Hercules*, *Rodney*, *Howe*, *Ajax*, *Neptune*, *Conqueror*, *Warspite*, *Black Prince*, *Invincible*, *Shannon*, *Undaunted*, *Galatea*, and *Medea.* In fact, the greater part of the British fleet had been fallen in with. At 7.40 a. m. Vice-Admiral Sir George Tryon, in the *Hercules*, had learned from the *Warspite* and from distant signals of the presence of the enemy in his neighborhood.

Being of opinion that the latter was likely to be in force, the vice-admiral determined to keep both divisions, his own and the rear-admiral's, in touch. With the former he steered so as to cut off the enemy if he stood to the westward. After some alterations of course, finding that the British were coming up fast, the *Anson* was put on a northwest course at full speed to try and draw the A ships off the French coast, in the hope, if they could be shaken off, that it would still be found possible to get round them by Ushant and pass up the channel in the night. This was frustrated by the British, who pressed the *Anson* and her friends with a force estimated by Rear-Admiral D'Arcy-Irvine at eight or ten battle-ships and a cruiser. Sir George Tryon and the division under him had shaped a course which, while it maintained the bearing from the enemy, converged on his until the two ships had closed to within 6 or 7 miles of each other. The vice-admiral's division, now strengthened by the arrival of the *Neptune* and *Conqueror*, continued in pursuit of the B division, still remaining complete. Having chased it for 97 miles to latitude 49° 30′ north and longitude 7° 12′ west and finding that he could not overtake them and it being clear that the enemy's ships could not interfere with Rear-Admiral Tracey's division, Sir George Tryon ordered his ships to return to their assigned stations. The chase had continued throughout the afternoon, and at 6 p. m. the *Australia*, having been directed to keep a watch on their opponents, the *Anson* and *Collingwood* returned towards Cape Clear.

A further conflict awaited them. Shortly before midnight four of A's cruisers were met. The *Anson* passed very close to one on her starboard hard and another to port. The cruisers fled. At 11.55 the *Anson* opened fire and was followed shortly by the *Collingwood.* The latter vessel dropped behind and could not obey the Admiral's signal to capture the *Galatea* and *Undaunted* on her starboard hand, while the *Anson* looked after the other two—*Narcissus* and *Aurora*—to port. During the chase of the latter the steam steering gear of the *Narcissus* broke down and she might have been captured had she been chased directly by the *Anson*, but the latter gave her attention to the *Aurora*, which, steaming 17 knots, ran away from the battle-ship. The *Narcissus* reached Plymouth on the 20th for repairs and left on the 22d to rejoin A Fleet.

It was claimed on behalf of the *Anson* and *Collingwood* that they had captured the *Aurora*. At the final adjudication the claim was overruled. At 4.30 p. m., on the 18th August, the two barbette-ships arrived at Queenstown. They were joined there by Vice-Admiral Baird in person, with the division under him, early next morning. Whilst the attempt to pass up the English Channel was being made by the detachment of B Fleet under the rear-admiral, the vice-admiral had been cruising to the southward of Ireland. On reaching Queenstown he learned the result of the engagements at the mouth of the channel, and on the same day gave directions for the carrying out of the second series of main operations. Though the ships selected to take part in these left Queenstown before the day was over, it will be more convenient to postpone the account of their proceedings until that of the movements of the cruisers employed in attacking and defending sea-borne commerce has been given.

CRUISER OPERATIONS.

It has been already said that several of B's cruisers were dispatched on the 15th to cruise, with the object of intercepting merchant shipping; the *Arethusa* and *Calypso* in the neighborhood of Ushant, and the *Mersey*, *Iris*, and *Magicienne* off the southwest and northwest coasts of Ireland. Subsequently the *Mersey* was sent to cruise off Ushant, and the *Australia* acted in concert with the *Iris* and *Magicienne*. The *Calypso*, as before observed, eventually took up the work of completing the defenses at Berehaven in conjunction with the *Nymphe*. On the 23d of August the *Grasshopper* and on the 25th the *Hecla* left Lough Swilly to look out for the merchant ships of the other side, and on the 25th the *Rattlesnake* left port with the same object. This vessel was disguised as a steam-collier and flew the red ensign of a merchant ship. Her name was obliterated, and the word "*Saxon*" painted on each bow; her smoke-stack was painted black, the distinguishing mark being a large white band with a blue Maltese cross in the center.

The work of attacking commerce was not carried on undisturbed. On the night of the 16th–17th August, the *Calypso* was chased by the A cruisers *Thames* and *Forth*. Under steam alone, against the wind, the *Calypso* made 11.8 knots an hour. A sudden alteration of course of 9 points enabled her to make plain sail to top gallant sails. Under steam and sail she went away at the rate of 15 knots and, favored by misty weather, escaped from her pursuers. She anchored at Berehaven at 3

a. m., on the 23d. Also on the night of the 16th–17th, the *Arethusa* fell in with these two cruisers and was chased by them for several hours, when, the weather becoming thick, she lost sight of them. On the 19th she was compelled to give up an attempt to capture a steamer, which still required half an hour for its completion, by the appearance of the *Mohawk* and *Thames*, by which she was again chased. The *Arethusa* returned to Berehaven on the 23d, and left again for further cruising the same day. On the 20th the *Mersey* sighted and gave chase to the *Mohawk*, but falling in with the *Thames* had to alter her course to the southwest. She lost sight of both vessels at 10.30 p. m.

During her second cruise the *Arethusa* on several occasions encountered ships of the other side. On the 25th she was chased. On the morning of the next day she was again chased by a superior force. At 6.30 a. m., on the 27th August, in latitude 48° 16′ north, longitude 6° west, Ushant light-house E. ¼ S., 37 miles, the *Arethusa* sighted the *Forth*, A cruiser. Not long afterwards the *Galatea* and *Warspite*, of the same side, were observed. Between 9 and 10 a. m. the friendly *Mersey* was seen, and the two ships remained in each other's neighborhood throughout the day, steaming away from their pursuers. At 8.37 p. m., according to the *Arethusa's* report, the chase, which had lasted fourteen hours, over a distance of 215 miles, terminated. The *Arethusa* and *Mersey* made 15 knots. Owing to the heating of her bearings, the *Warspite* dropped astern. The B vessels escaped in the darkness. The pursuing ships desisted when the time appeared to have arrived for claiming the capture of the *Arethusa* and the severe crippling, if not capture, of the *Mersey*. These claims were submitted at the final adjudication at Devonport. The decision, however, was against them, being to the effect that neither ship was captured or sunk, but that both had been driven off their cruising ground. The amount of activity displayed by B's fast cruisers will be most easily estimated if the general result of their cruises be stated. Six of these ships claimed to have captured 95 merchant vessels, or a total of 168,641 tons. It may be observed that the merchant vessels did not consider themselves to be engaged in the manœuvres, and therefore made few, if any, efforts to escape capture or to change course so as to avoid approaching an enemy's cruiser.

SECOND SERIES OF MAIN OPERATIONS.

The second series of main operations began on the 19th August with the dispatch from Queenstown of the *Anson* and *Collingwood*, under Rear-Admiral D'Arcy Irvine, to the North Sea. On the same day Vice-Admiral Sir George Tryon, with a fleet of nine battle-ships, two armored and three other cruisers, steered for Milford Haven and anchored in Dale Roads on the afternoon of the 20th. Information of this reached Vice-Admiral Baird at 7 p. m. On the forenoon of the 21st Sir George Tryon again started from Milford, encountering a high sea and a fresh wind from the westward. The *Hotspur*, *Sandfly*, and *Spider* were sent back during the afternoon. Sir George steered for the south coast of Ireland, and at 9 p. m. on the 22d August stood in for the Old Head of Kinsale. At the same hour Vice-Admiral Baird, with the *Northumberland*, *Monarch*, *Devastation*, and *Iron Duke*, left the anchorage to cruise off Queenstown. At 2.30 p. m. he observed hostile cruisers and shortly afterwards sighted the following ships of A: *Hercules* (flag), *Black Prince*, *Invincible*, *Northampton*, *Neptune*, *Conqueror*, *Rupert*, *Tartar*, *Forth*, *Warspite*, *Mercury*, and *Marathon*.

The *Warspite* and *Mercury* approached to within 3 or 4 miles, fired several rounds, and retired. At 4 p. m. the B Squadron returned to port, the *Monarch* having to stop five minutes en route to make good some defect in her engine, and defended it in case of attack by torpedo boats, the hostile A ships remaining in the offing. Having blockaded the enemy in Queenstown during the night and part of the following day, the 23d, Sir George Tryon decided to return to the channel. Three cruisers were sent to a position 60 miles west of Ushant. The rest of the fleet was spread, so that on the morning of the 24th the ships were 8 miles apart on a line drawn southwest from Scilly. Though a wide area was swept, no enemy's ships were seen. On going into Falmouth, Sir George received information that a detachment of B's ships was proceeding as though about to attack the east coast of Great Britain. To meet this, Rear-Admiral Tracey was ordered to proceed to the North Sea, the following ships being placed under his orders and dispatched as soon as they could be communicated with: *Rodney* (flag), *Howe*, *Narcissus*, *Thames*, *Medea*, *Undaunted*.

The *Anson* (flag) and *Collingwood* quitted Queenstown after dark on the 19th August and, passing to the west of Ireland and of St. Kilda, to the north of Rona and between the Orkneys and the Fair Isle, reached the neighborhood of Aberdeen on the afternoon of the 23d. They then moved at a low speed, so that they might arrive, the *Anson* off Aberdeen and the *Collingwood* off Peterhead, at daylight the next morning.

The capture of Aberdeen was effected, notwithstanding the vigilance of the *Watchful*, *Active*, and *Pigmy*, and also a premonitory signal from Kinnaird's Head early in the morning that suspicious vessels were passing to the southward, but too far off the land to be made out clearly. The *Anson* dashed suddenly into Aberdeen from the open sea before the defenders were well aware of what was taking place. Possession was taken of the *Clyde*, drill ship, and the provost was served with a formal notification from Rear-Admiral D'Arcy Irvine that the town was at his mercy and demanding an indemnity of £500,000, otherwise the town would be reduced to ashes, together with the destruction of docks and shipping. The city officials refused the ransom on the ground that the town had not been bombarded, and the volunteers were called out, the batteries manned, and a few shots were fired at the *Anson*. The latter remained the required eight hours before the place.

Peterhead, the centre of the fishery trade of the east coast of Scotland, was captured under similar conditions as Aberdeen between 4 and 5 a. m. The *Collingwood* stood in, took possession of the coast-guard station, and the following letter was sent to the provost:

> H. M. S. Collingwood,
> *Off Peterhead, August* 24, 1889.
>
> Sir: By command of the rear-admiral, the second division of the B Fleet, I am directed to requisition your town to the extent of £150,000 sterling, for which amount please hand to bearer the requisite security to insure its prompt payment. I regret that it should be necessary to levy such a heavy ransom on your peaceful and industrious inhabitants, but the exorbitant ransom exacted by your ships from the thriving port of Belfast almost before the outbreak of hostilities leaves me no alternative. I may add that if my officers do not return in two hours' time I shall reduce your town to ashes, destroy your shipping, and level your factories and work-shops to the ground.
>
> I have the honor to be, sir, your obedient servant,
>
> R. H. Harris,
> *Captain.*
>
> The Lord Provost of Peterhead.

Steps were taken to meet the demands.

The *Anson* was rejoined by the *Collingwood* at 3 p. m. The two ships standing to the southward were off the Firth of Forth at 6 a. m. on the 25th. The *Collingwood* was stationed to keep a lookout towards the entrance, while the *Anson* approached and ransomed Leith for £500,000. A letter was also sent to the lord provost of Edinburgh demanding a ransom of £1,500,000 to save the capital of Scotland from destruction. Here a rumor was heard of the movement of a force of A ships under Rear-Admiral Tracey towards the North Sea. It was also ascertained that the collier which had reached Longhope had been captured by the *Medusa*, as before mentioned. After remaining eight hours the *Anson* and *Collingwood* left the firth and shaped course to the northward. At 5 p. m. two torpedo-boats were sighted. During the ensuing first watch the boats approached to attack the battle ships. Rear-Admiral D'Arcy-Irvine attributed the failure of the attack to the continued use of the ships' search-lights, their speed of 11 to 12 knots, and the amount of sea on. Commodore Markham, in reporting from the other side, also attributed the want of success to the failure of the torpedo-boats to get near enough to the ships.

Next day, 26th, the *Inflexible*, which, in obedience to telegraphic orders from Vice-Admiral Baird received at 10 p. m. on the 23d, had left Lough Swilly on the 24th for an independent cruise on the eastern British coasts, was sighted by Rear-Admiral D'Arcy-Irvine. The turret-ship, at first unaware of the character of the two barbette ships, which she also had observed, made off with all speed to the southeast. At 1.30 p. m., the strangers being recognized, she communicated with the rear-admiral and was taken under his orders. The *Inflexible* had passed through the Pentland Firth, had chased a vessel supposed to be one of A's, and had exchanged shots with Wick. The three battle-ships, in the hope of finding G Squadron, again visited the Firth of Forth, arriving there during the afternoon of the 27th August. Leaving the *Collingwood* and *Inflexible* near Inch-Keith, the rear-admiral in the *Anson* passed up the Forth, but finding no traces of the hostile squadron, went to sea again with his three ships and steered to the southward. At daylight of the 28th, being off Shields, he exchanged shots with the *Tartar*, which had retired into the Tyne, and with the shore defenses, bombarded North and South Shields, then Sunderland, Hartlepool, and Seaham Harbor—whither the *Collingwood* had been sent—and Middlesborough. The time occupied by these bombardments and the intermediate movements was five hours and fifty-five minutes, viz, from 5 a. m. to 10.55 a. m.

Information of the proceedings of the enemy's ships had reached the Intelligence Department early and nearly continuously; and telegraphic messages repeating it were transmitted successively by the Admiralty to dispatch stations for communication to the British admiral. On the 19th the reported arrival of the *Anson* and *Collingwod* at Queenstown was telegraphed, and subsequently their reported departure, and on the 22d that they had been sighted off the Fastnet on the night of the 20th. On the 23d a report was telegraphed for dispatch to the admiral of A Fleet that some of B's ships were approaching Shields by the north of Scotland. Very early on the 24th intimation that this was not confirmed and was probably incorrect was telegraphed. Two telegrams were sent that the enemy was approaching Aberdeen and ultimately that the place had been captured. Between noon and 2 p. m. further information was telegraphed announcing that the *Collingwood* had attacked Peterhead and the *Anson* and *Australia* Aberdeen.

At 3.50 p. m. on August 24th Rear-Admiral Tracey started from Falmouth and arrived in the Downs at 2.10 p. m. on the 25th, with the *Rodney* (flag), *Howe*, and *Narcissus.* Telegrams were sent for transmission to him—at 6 a. m., 8 32 a. m., and 11.50 a. m—announcing that the two ships were making for Leith; that they were in the Forth; that a vessel (possibly *Australia*) was chasing a cruiser going south; and then that nothing had been heard of the *Australia* since the 20th. The rear-admiral quitted the Downs at 4.40 p. m., leaving word that the *Undaunted* and *Thames*, which, as it happened, came up with him soon after, and the *Medea*, all on their way up-channel, were to follow him. He reached the mouth of the Humber at 9.15 a. m. on the 27th, and at 1.45 p. m. received from the Admiralty a telegram repeating a report brought into Falmouth by No. 55 torpedo-boat, that the latter, on the previous night at 11 p. m., had seen four ships south of Portland standing east, which would not answer signals, and at 2.30 a. m. another squadron apparently in chase. The telegram also contained a report from a steamer just arrived at Devonport, stating that five ships had been passed off the port steering east. The telegram added that at 8.45

a. m. the *Inflexible* and a fast cruiser were reported from Dunnett Head station as probably going south. These reports brought up the strength of the enemy in the North Sea to three first-class battle-ships and two cruisers, while Rear-Admiral Tracey's squadron consisted of two battle-ships and three cruisers, a force insufficient under the rules to prevent the other side from getting the advantage should an encounter take place.

The rear-admiral accordingly moved to the southward to await re-enforcements. He reached Aldborough at 5.40. a. m. on the 27th. Besides some other telegrams, mentioning the whereabouts of the *Anson*, *Collingwood*, and *Inflexible*, the Admiralty telegraphed, at 4.55 p. m., that the *Australia* had been at Queenstown that morning and had left in the afternoon. This established the fact of her absence from the North Sea. At 9.45 p. m. the *Ajax* arrived; and Rear-Admiral Tracey, with his squadron thus strengthened, proceeded north at full speed. At 12.28 p. m. on the 28th of August the *Medea*, which had been sent on to Flamborough Head for news, returned with intelligence, which had been telegraphed from the Admiralty at 8 a. m., that the *Anson*, *Collingwood*, and *Inflexible*, after engaging Tynemouth and other places, were proceeding south. The rear-admiral at once organized his force in three divisions and formed "Divisions line ahead."

First division: *Rodney* (flag), *Undaunted*.
Second division: *Ajax*, *Thames*,
Third division: *Howe*, *Narcissus*.

The *Ajax* was not able to keep up and the formation was imperfect; the *Thames* was ordered to take her place. The *Medea* was on the *Howe's* port beam.

Beyond the rumor, which had reached him at Leith on the 25th, that Rear-Admiral Tracey was coming towards the North Sea, Rear-Admiral D'Arcy Irvine had received no certain intelligence of the approach or whereabouts of any British ships strong enough to encounter him. From Sunderland and Hartlepool, with his three ships, he continued to stand to the southward.

Between noon and 1 p. m., off Scarborough, in a thick haze, the two squadrons suddenly came in sight of each other, there being about a mile and a half between them. The *Anson* and her two companions, now unexpectedly made aware of the vicinity of a superior hostile force, put about and endeavored to escape to the northward. Rear-Admiral Tracey's ships went in pursuit. Owing to her want of speed, the *Inflexible* was quickly caught and surrounded, and being exposed to the fire of two heavy battle-ships and two cruisers, which she could not shake off, was compelled to strike between 1 and 2 p. m. The *Collingwood* kept ahead of her pursuers longer; but, owing to the priming of her boilers, her speed fell off. Escape being now impossible, the *Collingwood* was manœuvred so as to delay the pursuers and facilitate the escape of the *Anson*. At 3.38 p. m. the *Collingwood* was ruled out of action and the

A ships went after the *Anson*, the only ship of the B squadron now remaining, and she was hotly chased till dark by the *Howe* and *Narcissus*, making 16 knots speed, but the *Anson* escaped.

These two ships laid claim to the capture of the *Anson*, but it was disallowed at the final adjudication at Devonport. The manœuvre period was within a few hours of its termination, and this action ended both the second series of the main operations, and also the whole of the active proceedings of the manœuvres.

PROTECTION OF BRITISH COMMERCE.

A glance at the map will show where English commerce was most likely to suffer, if steps were not taken to prevent it. The lines of homeward-bound merchantmen converge naturally at the mouths of the English and St. George's Channels; and in the North Channel, on the route to the Mersey and Clyde. War having broken out, it might be that the extreme northern route would be taken by many ships bound to east coast ports. Hence in that direction also defensive measures were necessary. An enemy's cruisers looking for merchantmen would naturally seek the areas of concentration formed by the convergence of trade lines, so a fairly strong force was necessary at each of them to protect commerce.

To do this properly would require a larger force of cruisers than the British admiral had at his disposal, taking into account the numbers on the other side. Cruisers are needed for at least three purposes: First, to act as scouts; second, to keep up communication with the base; third, to protect commerce. Admiral Tryon had fifteen, Admiral Baird twelve, for these duties. Two scouts to a battle ship is a fair proportion to employ; therefore the rival admirals were short-handed from the first. To the defending admiral it was more important to know what the enemy was doing, and therefore it took all his cruisers to collect intelligence and carry dispatches. But the attacking fleet could lie in harbor or send out raiding squadrons unaccompanied by scouts. By doing the latter he increased the risk of losing his ships, but his game was to do as much harm as possible, and he considered his cruisers better employed in raiding commerce. Every night Sir George Tryon pushed out his cruisers from his line of observation between the Lizard and Ushant 25 or 30 miles, in the hope of capturing some of the commerce destroyers. He had no luck until the close of the operations, when Vice-Admiral Baird was safe in Queenstown, Rear-Admiral Tracey was dealing with Rear-Admiral D'Arcy-Irvine, and the scouts could be spared from the base, when they were pushed out double the distance.

The following is the list of prizes captured by the cruisers of B Fleet:

Date.	Name of capture.	Tonnage.
	Captured by Arethusa.	
Aug. 16	Dordogne	546
17	Streonshalt	891
17	Mosser	1,323
17	Gulf of Corcovado	1,482
17	Treneglos	1,039
18	Arthur	817
19	Kaisow	1,934
19	Landerdale	1,183
19	Kaikoura	2,885
19	Trent	1,142
20	Gordonia	1,555
20	Beyard	1,319
25	Eboe	441
25	Blythwood	770
25	Rhyl	883
26	Myrtle	915
26	Palma	735
26	Blencowe	304
26	Dago	1,239
28	Earlscourt	1,113
	Total	22,616
	Captured by Mersey.	
Aug. 15	Beila	1,400
15	British King	2,289
22	Maud Hartmann	1,070
22	Leven	1,500
22	Amity	923
22	Ardlethan	1,024
23	Gulf of Aden	1,572
23	Cartagena	1,533
23	Flintshire	1,222
24	Laplace	901
24	Caroline Spooner	663
25	Clan Munro	1,437
25	Incemore	1,118
25	Marie-Fleurie	323
25	Orestes	1,323
26	Author	838
26	Marie Bhan	1,315
26	Derwent	986
26	Victoria Bay	1,118
29	Lismore	1,596
	Total	24,151
	Captured by Calypso.	
Aug. 16	Guildford	2,152
16	Limpopo	1,324
17	Isle of Iona	1,102
17	James Cameron	1,765
17	Nant Francon	643
18	Salerno	2,488

Date.	Name of capture.	Tonnage.
	Captured by Calypso—Cont'd.	
Aug. 18	Grantully Castle	3,489
19	Mazeppa	1,114
19	Luxor	1,408
19	Queen	1,923
19	City of Bombay	4,407
	Total	21,815
	Captured by Camperdown.	
Aug. 16	Mardy	437
	Captured by Magicienne.	
Aug. 16	Cephalonia	3,490
20	Leander	848
20	Phosphor	1,326
22	Wisconsin	2,386
22	Britannic	3,152
23	Celtic	2,439
23	Brooklyn	1,122
24	Tiber	1,134
26	Bavarian	2,027
25	Arizona	2,657
26	Servia	3,971
	Total	24,552
	Captured by Australia.	
Aug. 20	Baltimore	2,459
21	Scotsman	1,075
22	City of Chicago	3,383
23	Oranmore	2,215
23	Scythia	2,907
25	Rossmore	2,300
26	Dominion	2,032
27	City of New York	5,930
28	Elginshire	1,353
28	Teutonic	12,500
	Total	36,154
	Captured by Grasshopper.	
Aug. 21	Liverpool	700
23	Anchoria	2,713
24	Colina	1,297
24	Lake Ontario	2,923
25	State of Georgia	1,537
	Total	9,170
	Captured by Iris.	
Aug. 17	Jane Williamson	100
17	British Princess	2,558
18	Pictou	1,561
18	Minnesota	2,053
20	Scholar	1,027

Date.	Name of capture.	Tonnage.	Date.	Name of capture.	Tonnage.
	Captured by Iris—Cont'd.			*Captured by Iris*—Cont'd.	
Aug. 20	Eliza Jane	170	Aug. 23	Sierra Madrona	1,430
21	Rachael Harrison	150	25	Maria Stoneman	700
21	Nova Scotian	3,305	27	Bellingham	1,066
22	Cambrian Princess	1,350	27	Devonia	2,772
22	City of Paris	5,581		Total	29,751
22	Britannic	3,152		Grand Total	168,641
22	Lord Clive	2,206			
23	Tamaya	570			

UMPIRES' DECISIONS.

The following is a list of the seven disputed cases and the decision in each:

No. 1.—The claim of the *Mercury* to have captured Kingstown, and the counter claim made by the Inspecting-Commander of Coast Guard, Kingstown, to have sunk the *Mercury.*

The *Mercury* stood into Kingstown between 1 and 2 o'clock in the afternoon of the 15th August, under the fire of the batteries at Sandy Cove and East Pier. It appears by her log that at 2.50 p. m. she lowered a boat and sent a letter to the lord lieutenant. At 3.10 p. m. the boat returned and the *Mercury* proceeded to sea. The ship having been only three hours at the most in the vicinity of the port, she can not be considered to have made a successful attack upon Kingstown, under Rule 2, Defended and Undefended Ports, which lays down that the attacking vessel must remain for eight consecutive hours within 5 miles of the port attacked.

As regards the claim that the *Mercury* was sunk by the batteries there is no rule applicable to this case. It does not appear to have been contemplated that ships would engage batteries.

No. 2.—The claim of five torpedo-boats to have destroyed the shipping in the Liffey, and the counter-claim that the boats were destroyed by the Pigeon-House Fort and the Coast Guard.

The torpedo-boats apparently steamed up the Liffey unmolested, and, having destroyed the shipping at the custom-house quay, steamed back. On passing the Pigeon-House Fort they were subject to a heavy fire for ten minutes from the guns of the fort, and also from the Coast-Guard Station at close range. In this case, again, there is no rule which applies to it, but the boats having been exposed to fire for such a time in daylight, it is reasonable to suppose that some of them would have been damaged.

No. 3.—The claim made by *Camperdown* to have captured the *Thames* in the morning of August 17.

The evidence in this case is very conflicting. The captain of the *Camperdown* considers that his vessel was within 3,000 yards of the

Thames for one hour. The captain of the *Thames* states that the two ships were not within 3,000 yards of each other for the prescribed time. The *Camperdown* did not bring her barbettes into action nor did her captain signal to the *Thames* that he considered her captured. As far as the rules affect the case, it was decided to be a drawn battle, although in absolute warfare a protected cruiser could not have passed so close to a battle-ship with impunity.

No. 4.—August 17, the claim of ***Rodney*** and ***Howe*** to have captured *Hero* and *Camperdown.*

These two cases hinge upon the construction put upon Rule 1. Whether, in the first place, two vessels several miles apart retreating before a superior force can be considered a squadron or part of a squadron; in the second place, whether the expression "to have gained the advantage in the engagement" can be considered to mean the capture of both ships of the inferior force.

As to the first point, the two ships being so far apart were no real support to each other; and it was considered that the question shall be decided under Rule 3. As regards the second point, "one squadron having gained the advantage over the other," can only be intended to mean that the superior squadron had frustrated the object the inferior squadron had in view, obliging it to retreat; and the only ships of the inferior squadron which could be captured were those coming under Rule 3, as having been under fire for two hours within 3,000 yards.

It would have been quite possible for the ships of A Fleet to gain an advantage over B Fleet by forcing them to retreat, thereby frustrating the design of the admiral of B Fleet, irrespective of the nearest ships being within 4,000 yards of each other. The *Hero* therefore, having been more than two hours under the fire of the *Rodney* and *Howe* within the range of 3,000 yards, was captured under the rules, but the *Camperdown* having been only twenty minutes under fire should not have been ruled out of action until one hour and forty minutes later. Therefore she was not captured.

No. 5.—August 17 and 18, the claim made by Rear-Admiral D'Arcy-Irvine, with the *Anson* and *Collingwood*, to have captured a cruiser, supposed by him to be the protected cruiser *Marathon*, but which proved to be the armored cruiser *Aurora.*

In this case the reports of the officers and of the umpire on board the *Anson* agree in stating that the cruiser was within the limit of 3,000 yards for one hour; this is also proved by the *Aurora's* log. The only question, therefore, to be decided is as to the reading of Rule 4.

The umpire on the *Anson* contends that under this rule the term "protected vessels" includes armored cruisers; but Rule 7 clearly lays down that armored cruisers are inferior to battle-ships, but superior to armored coast-defense vessels and protected vessels; and that protected vessels are inferior to armored coast-defense vessels. An armored coast-defense vessel is certainly an ironclad; its superior, an armored cruiser, must consequently be considered an ironclad, and as such it was decided that the *Aurora* was not captured under Rule 4, but that the case should have been judged under Rule 3, which would have necessitated the engagement lasting two hours.

No. 6.—August 27, the claim made by the *Warspite* and *Galatea* to have sunk the cruiser *Arethusa* and to have severely crippled, if not captured, the *Mersey.*

There is no rule which applies to this particular case of one armored cruiser being within 3,000 yards of two protected vessels. No doubt the *Galatea* was supported by the *Warspite*, 3 or 4 miles astern, and may be considered to have gained the advantage under Rule 1; but there is no rule providing for the capture of two protected vessels by an armored cruiser inside the 3,000 yards, and a battle-ship (*Warspite*) 4 miles distant.

It was decided that neither the *Arethusa* nor *Mersey* was captured or sunk, but that they were so far defeated that they were chased off their cruising-ground.

No. 7.—August 28, the claim made by the *Howe* and *Narcissus* to have captured the *Anson.*

In this case the *Howe* and *Narcissus* chased the *Anson* from 2.52 until 5 o'clock, *Narcissus* being between 2,500 and 1,500 yards, while the *Howe* could never get within 3,000 yards.

It was decided by Rule 1 that the advantage is on the side of the *Howe* and *Narcissus*, the *Anson* having been obliged to retreat, the object she had in view being defeated, but that she was not captured.

CASUALTIES.

On leaving Spithead the weather was so bad that many of the ships were unable to weigh without considerable delay. The *Inflexible's* steam-capstan broke down, and no sooner had the fleets made a start than the *Invincible* and *Black Prince* came into collision, the latter losing her head-gear and the former carrying away the mizzen-topmast and smashing a cutter. The *Hercules* broke down and had to put into Portland for repairs, and later, on entering Milford, collided with a schooner. The *Active* ran down a German bark; another collision on the part of the *Northampton* was imminent.

Steam steering gear was a fruitful source of break-downs in several ships, including the *Narcissus*, *Australia*, *Ajax*, *Undaunted*, and *Howe.* Leaky boiler-tubes also caused trouble. The *Melpomene* and *Spider* had to go to a dock-yard on that account. The *Australia* narrowly escaped accident, owing to the breaking of a feed-pipe, and the *Grasshopper* had to run back to Portsmouth under sail, owing to a break-down. Some gun-boats and nearly all of the torpedo-boats developed defects. The *Forth* became disabled temporarily and the *Monarch* had the misfortune to break down off Queenstown when being pursued by the enemy.

On the trial speeds the *Hero* had some trouble with her boiler-tubes, but the defect was made good in a few hours.

On the 9th torpedo-boat No. 23 fouled No. 34 in Hamoaze and started some of the latter's rivets; the *Collingwood* had to fall out for some time to repair a defect in one of her engines; and the *Australia* called at Plymouth with defective cylinder-head and feed-pipes.

On the 10th the *Narcissus*, belonging to A Fleet, left Plymouth for Milford Haven after repairs to her main steam-pipe and cylinder-head.

On the 14th a torpedo-boat, in returning from a trip to one of the vessels outside Berehaven, knocked a hole in her bow by colliding with the *Devastation.*

On the 16th the *Pigmy* was towed into Peterhead by the *Watchful* with one of her cylinders broken down.

Torpedo-boat No. 50 reached Bantry Bay on the 17th, her engine having broken down in a gale, during which she became separated from the *Hecla.*

On the 20th torpedo-boat No. 61, while proceeding up Sheernees Harbor, lost her steam and drifted with the current. She fouled the *Beaver*, lost her mast, part of the starboard rail, had one of her boats stove in, and her search-light and fittings damaged.

On the 21st, torpedo-boats Nos. 4 and 72, of E Squadron, put into port to repair machinery.

On the 23d, No. 41 was towed into Lough Swilly, having broken down in a gale, during which she narrowly escaped being lost. The crew suffered greatly.

These casualties are mentioned not for the purpose of dwelling on defects, but to illustrate further the importance and value of the manœuvres. A ship in permanent commission is always less liable to break downs, whether serious or trivial, than one newly commissioned and sent to sea for the first time, but every day the latter remains at sea the more efficient she becomes. Such operations show beforehand what a fleet can do and the ships on which the greatest reliance can be placed.

COMMENTS.

The obviously simple plan for the admiral of B Fleet was to deliver one blow, probably with his fastest ships and without delay, and then, while the defending admiral was parrying this stroke, to cut in and deal another with crushing effect. If he had dispatched his fast squadron round the north coast with orders to keep out of sight of land, it is possible that the British admiral would not have heard of it until three or four days later, when it appeared off the East coast. It would then have been much as he could do to get his fastest ships to the Downs before the enemy was at the Nore.

A second opening for the first attack was Liverpool, for the appearance of vessels in the Irish Sea, with instructions simply to appear off the mouths of the Mersey and the Clyde and then retreat, would hardly fail to draw a strong part of A Fleet away, leaving the channel clearer for the other ships to attempt.

The third opening was to deliver a blow at the Thames by the channel directly war was declared, and, when Admiral Tryon was engaged in chasing B's fast ships, raid the west coast with the remainder of the fleet.

Some English critics think that Admiral Baird invited disaster by sending his fast division up the channel as single ships, instead of as a squadron in close order with cruisers scouting ahead; that he should have timed their arrival at the pass between the Lizard and the French coast at 2.30 or 3 a. m., instead of attempting this entrance to the channel, which could be easily watched with seven fast ships, in broad daylight; and that the fast squadron should have been instructed to run this pass at full speed; also, that with his slow squadron he should have attacked Liverpool, then Greenock, and the Lamlash squadron. They furthermore contend that, had the fast squadron attempted the Lizard passage at night under a full head of steam, it would probably have passed through, or, if the enemy were found too strong, it could stand off and attempt it the next night, when, after news of the events off Liverpool, it would probably have succeeded in forcing the channel. He should have sent, too, one fast cruiser with the *Anson* and *Collingwood* when they were dispatched to raid the East coast.

It seems clear that the plan failed, not so much through delay as through non-concentration; and it was a mistake to join the *Hero*, which was not good for more than 13 knots, with the *Camperdown*, which could make 15 knots with ease.

That Admiral Baird was not rendered almost powerless by the loss of three out of his six fast vessels speaks much for the advantage possessed by the attack over the defense.

When the *Anson*, *Collingwood*, and *Inflexible* were dispatched by the north to raid, the remainder of B Fleet was kept in harbor. It is here that one of the chief lessons of the manœuvres came in. The principal part of B Fleet was now in Queenstown, a fortified port, but the defending squadron, instead of being close outside the harbor, was out of sight; was masking instead of blockading. The advantage to A Fleet is apparent. Neither the ships nor men were overtaxed; the admiral was in hourly communication with the Intelligence Department, which transmitted to him information gathered from all round the coast; his cruisers and torpedo-boats also picked up news of the enemy's movements and enabled him to parry their thrusts. Better still, his whereabouts was unknown to his opponent, and by the ruse of appearing off Queenstown one evening and leaving a few cruisers there for a day or two, with orders to use their distant signals as if communicating with him, he led the B Fleet to believe they were blockaded, while in fact he was coaling at Falmouth.

The manœuvres also tested the organization and equipment of the Navy. The work of getting ships ready for the first reserve, which was one of months, is now one of weeks, owing to the system introduced and improved by these trials. The shortcomings of the reserve of officers, seamen, firemen, and signalmen are becoming better understood and, therefore, more capable of remedy.

Then, again, the very defective means of receiving and imparting information on the subject of impending raids, appearance and movements of the enemy's ships, and so on, hitherto existing, has been much remedied. The new intelligence system worked very well this year, but developed a still further need of signal stations connected with the telegraph system and that better means be devised for defending them from raiders.

"Flag Officer," in Colburn's United Service Magazine for November, 1889, comments as follows:

The *Anson* could not fire her big guns because her electric gearing went wrong.

The belted (armored) cruisers labored under the very serious defect of an insufficiency of speed. The manœuvres made it manifest that speed on the measured mile and speed on active service are two very different things. The belted cruisers fell about 4 knots an hour short of their reputed speed, and other vessels, which have less to commend them, show a similar deficiency. This is a very serious matter, for a speed of 14 or 15 knots is by no means sufficient for the purposes for which cruisers are especially designed.

There is also a further difference between large and small vessels in that the speed of the latter more rapidly decreases with the lessening of length in proportion to beam. The trial in the channel between the *Mersey*, of 4,050 tons and 6,000 horse-power, and the *Magicienne*, of 2,950 tons and 9,000 horse-power, resulted in the latter, with about 3 horse-power per ton, being beaten by the *Mersey*, which has only about 1¼ horse-power per ton; but the latter had the advantage of 35 feet greater length and 2 feet more draught of water. The rolling of some of the vessels was so great that, at times, it seemed to the correspondent watching the *Magicienne* especially, that she would turn over and, as a matter of course, could not, when working so heavily, have fought her guns.

The very low free-board of the *Admiral* class and their deep rolling would render them almost equally helpless in a heavy sea. The Standard's correspondent thus describes the behavior of the *Collingwood* when off the north coast of Scotland:

"The strong southwesterly wind had now freshened into a gale, and with this gale came a huge sea that not only washed our quarter-deck and our whole ship from stem to stern, but even rose to our spar decks and drenched our bridges. Deluges of water poured upon us. * * * That the *Collingwood* was a sea-boat, though a roller, is not to be denied."

On this occasion her torpedo-booms were smashed.

It was also shown that the barbette guns of the *Admiral* class are not strongly supported, for the iron beams known on board by the name of "cloisters" might be easily knocked away, as they only rest upon carlines on each side and are without

> any armor protection. As a result the armor beneath the barbette towers of the proposed eight 14,150-ton battle-ships has been carried down to the level of the armored belt, instead of being only attached to it by the slender-plated ammunition-hoist, as in the *Collingwood* and sister vessels.
>
> Another serious defect which has been shown by these manœuvres to be almost general in our war-ships is the small quantity of fuel carried; the lack of coal proved a serious drawback to ships close off the ports of Great Britain and Ireland. Even when the coal was placed on board the arrangements for its supply to the fires proved so inefficient that, in many cases, steam could only be kept up by means of a large body of sailors to help bring the coal to the furnaces. As a result of the manœuvres the bunkers of the *Aurora* were altered and rebuilt to admit of the coal being easily brought to the fires.
>
> The causes of many of the shortcomings are the lack of naval experience in designing our ships and the want of due appreciation of the great improvements in size, speed, and sea-going qualities of large merchantmen which have been attained by means of increased tonnage and a far higher steam-pressure. * * * Economy of coal, combined with the improved form of the "greyhounds of the ocean," has resulted from practical knowledge and long experience; but the shortness of our later war-ships appears to have been, at least in part, derived from experiments with models, tested in a large tank or basin, from which no criterion of speed under the changed conditions of sea and swell could possibly be obtained.
>
> The form of the narrow receding bow, instead of tending to the maintenance of speed, appears to have a directly contrary effect, for it allows the ship to pitch more deeply and the water falling on board presses her bow still further down into the wave, with the result so unpleasantly experienced in the *Collingwood* when off the Island of St. Kilda.
>
> The lessons derived from the reports of the manœuvres have led to the laying down of battle-ships and first-class cruisers, each nearly 2,000 tons larger than those previously built, and have likewise occasioned the building of gun and torpedo vessels of increased dimensions.

By direction of the Admiralty, Mr. W. H. White, the chief naval constructor was on board the *Howe* during the manœuvres; in this way he ascertained personally whether the ships of the fleet were in a satisfactory condition. He was not only a spectator, but was also willing to hear both criticisms and suggestions about the design and equipment of modern men-of-war.

A writer in Blackwood's Magazine for October, 1889, who speaks apparently with authority, comments as follows on the several types of ships in the fleets:

> With reference to the behavior of the various classes of ships engaged in the manœuvres, it may be broadly stated that the ships of the *Admiral* class, viz, *Anson*, *Rodney*, *Camperdown*, *Howe*, and *Collingwood*, acquitted themselves satisfactorily. They were able to maintain good speed at sea, and, in spite of their low free board, it was possible to drive them at fair speed against very strong breezes and comparatively heavy seas, though of course under these circumstances they were very wet, taking in green seas over the foremost barbette.
>
> The so-called "belted (armored) cruisers" of the *Undaunted* type—six of which were engaged in the manœuvres—may also be said to have acquitted themselves fairly well as to speed, and as to their power of fighting their powerful armament in almost all weathers.
>
> Some of the older cruisers acquitted themselves very well; but the newest type of all—viz, the M class, consisting of five ships—must be pronounced failures. They were designed to steam 19¾ knots, and their captains say they can only do about 15,

> Their principal defect seems to be in their boilers, which were made too light for the work. This defect may perhaps be partially rectified, but the ships themselves are too short, too low in the water, and their lines are too hollow to admit of high ocean speed. The above are the characteristic vices of all our cruisers, including the so-called belted cruisers.
>
> Perhaps one of the most eminently successful vessels engaged in the manœuvres was the little *Rattlesnake.* She maintained high speed in all weathers, and she did an immense amount of work.
>
> The continued bad weather also proved once more that the torpedo-boats are purely fine-weather birds. We were not so unfortunate as to lose any of them by capsizing or otherwise, though some had narrow escapes; but, on the whole, they may be said to have been useless to either squadron; in short, the weather was too bad for them. Those that went round the west coast of Ireland had a very rough time of it. They had to put into several ports for shelter, and only traveled by day; and when they got into Lough Swilly they had many defects, and took a long time to put to rights and get ready for service, after which they still continued to come to grief. One broke down on a lee shore, blowing hard with a good deal of sea on, and would probably have been lost with all hands had she not been cleverly rescued by H. R. H. Prince George of Wales, in No. 79, and safely towed into Lough Swilly. In short, the torpedo-boat, so far as any effect they might have had (under more favorable circumstances) upon the issues of the mimic warfare went, were, under the conditions of weather encountered in August, 1889, quite useless. Not so, however, the value of them as a training school for the officers and men employed in them, but more particularly for their commanders. This value it would be almost impossible to overestimate.
>
> The risks incurred by working heavy iron-clads at high speeds, as assumed enemies, were justified in view of the value of the experience gained by so doing.

The necessity of a free use of coal and high speed in modern ships by way of training to officers and men seemed in the nature of a discovery.

Looking at the various types engaged it is evident how full-rigged ships, such as the *Invincible* or *Shannon*, would fare if struck in their useless tophamper by an enemy's projectiles.

Several vessels with military tops removed them, as they indicated their character even when the ships were hull down, retarded the speed when steaming, and made the ship roll quite unnecessarily.

The experience of the manœuvres has shown that the complexity and variety of fittings and machinery of modern war vessels renders it impracticable for any crew, however good their general training may be, to satisfactorily handle at the outset a new ship to which they have been hastily transferred.

Briefly expressed, the General Idea of this year's manœuvres was to mask the enemy's fleet from a suitable strategical base and to protect the English coast. The general result is expressed briefly in the following words of Rear-Admiral Richard C. Mayne, C. B., M. P.:

> Masking could only be successful with a very large force of cruisers and scouts. *The coast-defense flotilla. as in* 1887, *offered no impediment to enemy.*

FRANCE.

Important manœuvres to ascertain the vulnerability of Toulon began on the 23d of January by day and night attacks on the forts and batteries commanding the harbor.

The evolutionary squadron, under the command of Vice-Admiral Du Petit-Thouars, represented the attacking force. It consisted of the *Colbert*, *Dévastation*, *Redoutable*, *Amiral Duperré*, *Courbet*, *Caïman*, battle-ships; *Condor*, protected cruiser; *Milan*, unprotected cruiser; *Dragonne* and *Flèche*, torpedo vessels.

These vessels formed two divisions, as follows:

First division: *Colbert*, flag-ship of Vice-Admiral Du Petit-Thouars; *Amiral Duperré*, *Courbet*, *Condor*, *Milan*, and *Dragonne*.

Second division: *Dévastation*, flag-ship of Rear-Admiral Devarennes; *Redoubtable*, *Caïman*, and *Flèche*.

The defense was represented by the forts and batteries of the port. The outer roadstead is commanded on the east by three forts and two heavy batteries, and on the west by seven batteries. Their armament consists of 19, 24, 27, and 32 centimetre guns. The inner harbor is under the direct fire of four strong forts. Submarine mines protected the channels. Detachments of marine infantry were stationed in the fortifications and on the lines between them; and, in anticipation of a landing from the squadron at points of the coast not readily commanded by the forts, battalions of infantry, 250 strong, were stationed at each.

The object of the attacking fleet was to bombard the forts and batteries, to destroy the signal stations, and to enter the harbor of Toulon.

The 23d of January opened cold and wet, with a dense fog, but by noon the latter lifted, and the squadron got under way for the Hyères Islands, 15 miles southeast of Toulon, and its base of operations. By 3 p. m. the forts and batteries were ready for the attack and the signal stations were directed to keep a good look-out.

NIGHT ATTACK.

At 5 p. m. the squadron was sighted in the southwest steaming in column of divisions, the *Condor*, *Dragonne*, and *Flèche* acting as scouts. As darkness came on, search lights were thrown on the approaches, and eight vessels of the squadron were soon made out. Admiral Du Petit-Thoaurs ordered one torpedo vessel to the eastward and another to the westward to destroy the search lights. At the same time the squadron changed formation to line abreast, a light vessel remaining in rear to repeat signals.

Seeing the torpedo vessels driven back by the batteries, the commander-in-chief ordered the squadron to open fire, and at 6 o'clock the action became general; the first division engaged the eastern batteries, the second those on the west. The fire of the former was especially accurate and vigorous.

The search lights were directed first on the two flag-ships, whose positions were indicated by their signals to the other vessels. The *Redoutable* was held for some time under the rays of one of these lights, during which she was exposed to the fire of the 32-centimetre guns of two strong batteries.

Other lights showed the *Condor* approaching the coast at great speed, her aim being to destroy these reflectors in turn. Realizing her discovery, she opened fire with her machine guns; but three batteries concentrating their fire on her she was soon put out of action and forced to withdraw.

To avoid crossing the outer line of torpedoes, the squadron steamed at reduced speed while replying to the fire of the forts. None of the battle-ships were silenced by the latter. At 7 o'clock signal was made to cease firing, and the squadron returned to its base.

DAY ATTACK.

At 9 a. m. next day the semaphores signaled the approach of the squadron from the Hyères group. It was in column of divisions, steaming at 10 knots, the *Condor*, *Dragonne*, and *Flèche* again acting as scouts.

At 9.30 the first division changed course and steered for the open; the second division, increasing its speed to 11 knots, reconnoitred the coast and harbor entrance, and at 11 o'clock steered to join the commander-in-chief. At 1 p. m. the squadron was again sighted, heading for Toulon, in double column by divisions. At 3 miles from shore topmasts were housed, and the squadron formed line abreast at intervals of 800 metres, the *Colbert* being on the right and near the eastern shore. At 2.15 the first division opened fire on the eastern batteries, and a few minutes later the second engaged those on the west. The squadron meanwhile approached the entrance, and at 500 metres from the breakwater the admiral ordered all the vessels by signal to force the channel, using the guns in the military tops to sweep the parapets and embrasures of the forts.

During this operation the engagement reached its height, the ships being exposed for twenty-five minutes to heavy fire from the 32-centimetre guns. At 3 o'clock the *Colbert* rounded the breakwater, followed by the other battle-ships in column. Each ship had also to undergo the fire of the inner line of forts.

By 3.45 the action ceased, and at 4 the squadron anchored in the harbor of Toulon.

These operations were intended simply as a test of Toulon's defenses by land. The results were valuable as showing that two of the largest forts were lacking in armament, and that some of the batteries did not have sufficient elevation. It was also apparent that the fire of the forts was inferior to that of the ships; it was too rapid and pointing was much neglected. The fire of the battle-ships was careful, deliberate, and remarkably accurate.

CAPTURE OF NICE.

The same squadron, re-enforced by the *Amiral-Baudin*, battle-ship; the *Couleuvrine*, torpedo vessel, and the *Coureur* and *Déroulède*, deep-sea torpedo boats, continued its manœuvres on the 13th of March. It was free to act between Cannes and the frontier of Italy, the object being to test the value of the defenses of this part of the coast, along which a railway extends. Its immediate plan of operations was to cut the communications between the intrenched camp at Nice and the interior.

Detachments of the army, assisted by torpedo boats, undertook the defense. Armored trains were formed, signal stations occupied, and batteries garrisoned.

The general commanding the defense was informed by Admiral Du Petit-Thouars of the hour and probable duration of the attack.

Accordingly at 4.30 a. m., on the 13th, the action began and lasted till 10 o'clock. Details are lacking, and it can only be stated that the ships were victorious, the Var bridge, the most important point of the line, was captured and the communications between Nice and the interior thereby severed. The open valley of the Var, including the bridge, was commanded by the guns of the fleet; and in consequence neither infantry nor field artillery could co-operate in the defense.

SUMMER MANŒUVRES—MEDITERRANEAN.

The forty-five vessels of all types, including torpedo boats, mobilized for the summer manœuvres, were divided into two squadrons, as follows:

FIRST SQUADRON.

Rear-Admiral ALQUIER, commander-in-chief.

Dévastation (flag), *Amiral Baudin*, *Formidable*, and *Duperré*, battle-ships.
Duguesclin and *Bayard*, armored cruisers.
Milan and *Inconstant*, unprotected cruisers.
Fusée, armored-gun vessel.
Corse, armed dispatch vessel.
Bombe, *Dague*, and *Flèche*, torpedo vessels.
Challier, *Cuny*, *Déroulède*, *Doudard de Lagrée*, *Mehl*, and *Gabriel-Charmes* (No. 151), deep-sea torpedo boats.
And sixteen torpedo boats, first and second classes.

SECOND SQUADRON.

Rear-Admiral O'NEILL, commander-in-chief.

Vauban (flag), armored cruiser.
Courbet and *Redoutable*, battle-ships.
Condor, protected cruiser.
D'Estrées, *Papin*, and *Seignelay*, unprotected cruisers.
Dragonne, torpedo vessel.
Coureur and *Balny*, deep-sea torpedo boats.

The following General Idea was adopted:

A maritime power, with whom hostilities exist, prepares a fleet, which, arriving from the Mediterranean, occupies Ajaccio (Corsica) as a base of operations from which to attack the littoral zone, comprised between Cette on the west and Hyères Roads on the east; a French fleet of superior strength but inferior in speed is stationed in Toulon as a base and in other strategic positions of the defense zone, and is to be utilized by the admiral in command for the protection of this part of the coast.

The defense, therefore, devolved upon the first squadron; the attack upon the second.

Hostilities were to begin on the 1st of July. Admiral Alquier meanwhile assembled the vessels under his command at the Hyères anchorage; the armored ships were to remain together, and the smaller vessels to be in readiness to act as scouts. The *Dévastation*, *Formidable*, and *Amiral Baudin* formed the first division of the armored vessels; the *Amiral-Duperré*, *Duguesclin*, and *Bayard*, the second.

Before the manœuvres opened, four principal points of the defense zone were provided from this fleet with mobile defenses, as follows:

Toulon and Cette: Four torpedo boats each.

Bandol: Five torpedo boats, supported by the *Corse*, representing an armored gun vessel.

Marseilles: Five torpedo boats, supported by the *Fusée*. Hence to protect the threatened zone of 200 kilometres length, Admiral Alquier had thirteen battle-ships and cruising vessels and twenty-two torpedo boats of all types.

The land defense was not represented; the signal stations, however, could be used for the transmission of intelligence or orders.

The *Courbet*, *Redoutable*, and *Vauban* formed the armored division of the second squadron, as with the defenses the smaller vessels were used as scouts. By the 1st of July this squadron had assembled at Ajaccio.

The rules provided that the attacking squadron should take account of the fact that the coast batteries were not included in the defense; that its armored vessels could steam 9.5 knots per hour, while those of the defense should not exceed 8 knots; that the light vessels of each squadron could develop $\frac{9}{10}$ of their highest speed; that the first squadron was not to get underway until its scouts had reported the second's departure from Ajaccio; and the relative value of the armored ships of the two squadrons was so arranged that two of the defense were necessary to contend with the *Courbet*, and at least four of the defense to engage the three of the attacking division.

Vice-Admiral Du Petit-Thouars, on board the *Desaix*, acted as umpire.

The foregoing requirements show that Admiral Alquier could not assume the offensive at the beginning of hostilities; and that, though Admiral O'Neill had a smaller number of vessels, he had greater speed and could avoid his opponent when he wished. He had also a larger number of fast cruisers for scout service.

On the 30th of June the *Inconstant* and *Milan* were dispatched by Admiral Alquier to watch the movements of the Second Squadron. These two vessels cruised off Ajaccio till daylight next morning.

Admiral O'Neill had ordered his scouts to be ready to get under way at 1 p. m. on the 1st, and the armored vessels at 2. Accordingly at the first hour the *Seignelay*, *D'Estrées*, *Papin*, *Condor*, and *Dragonne* left Ajaccio and stood to sea in various directions in search of hostile cruisers. The *Seignelay* and *Condor* soon sighted the *Milan* several miles to the north, and gave chase. The latter escaped, and her pursuers changed course to the southwest, leaving far behind them the *D'Estrées*, which could not steam more than 8½ knots at best. The *Milan's* flight was merely a feint, however, for, returning on her course, she found the *D'Estrées* single-handed, and captured her in sight of the battle-ships in Ajaccio. At 3 o'clock the *D'Estrées* resumed her place at the anchorage, to undergo the penalty of being a loss to her own side for twenty-four hours.

Just outside of Ajaccio Admiral O'Neill found himself watched by the *Milan*, and sent the *Condor* in pursuit of her. The *Seignelay* and *Dragonne* were ordered to attack Cette; the *Courbet* and *Coureur* to the Bay of Bandol; the *Vauban*, *Redoutable*, *Papin*, *Condor*, and *Balny* stood direct for Marseilles.

The *Seignelay* and *Dragonne* reached Cette at 1 p. m. on the 2d of July. They entered the port before the semaphores could signal the fact to the torpedo-boats, which were thus surprised and unprepared for action. They were driven back by the *Dragonne*, while the *Seignelay* fired on the town.

The *Courbet* and *Coureur* about 2 p. m. appeared off Bandol, and allured the defense vessels into the offing; the latter, perceiving too late the feint, stood in-shore and steamed westward. The former vessels then seized Bandol and La Ciotat, successively, destroying the Bandol viaduct and all the supplies in the store-house of La Ciotat.

Admiral O'Neill, at a little before noon, had reached Marseilles. The *Vauban* and *Redoutable*, accompanied by the *Balny*, bombarded the city, and cruised four hours before it. During this operation the *Condor* and *Papin* were in sight on scout service, watching for the arrival of the defense squadron.

It was not till 10 p. m. of the 1st that the *Inconstant* returned to the flag-ship with news of the adversary's departure. At 2 a. m. following, Admiral Alquier got under way, leaving the *Bayard* at the Hyères anchorage, her sailing being delayed by an accident to her machinery. The defense squadron steamed in close order, the look-out ships about 3 miles ahead, and the torpedo-boats abreast of the armored vessels and 100 metres from them. Fearing an attack on Toulon, as well as the capture of the *Bayard*, the squadron manœuvred during the night between Bandol and Hyères Islands. At daylight the semaphores signaled the approach of two armored vessels, which proved to be the *Bayard*, coming from the eastward, and the *Courbet* from the southward. As the latter was the faster vessel, the defense squadron steamed for the *Bayard*, to protect her. Seeing this, the *Courbet* disappeared to the southeast, making many signals, as if the attacking squadron were in that direction.

After this incident, which occurred off Toulon, Admiral Alquier learned, through the signal stations, that the latter force was already at Marseilles; he steered at once for that port, but did not arrive till after the bombardment. When his approach was signaled by the *Papin* and *Condor*, the Second Squadron withdrew. A few shots were exchanged, but at a long distance. Notwithstanding the inferior speed of its battle-ships, the defense gave chase, relying upon its cruisers and three deep-sea torpedo-boats to make an attack after night-fall. The *Amiral Duperré* and *Duguesclin*, with two deed-sea torpedo-boats, remained in the vicinity of Marseilles to protect that city from the *Courbet* and *Coureur*. At 10 p. m. the hostile division was attacked by the defense torpedo-boats and cruisers, who claim to have struck the *Redoutable*, but no record appears of its being allowed by the umpire. After this engagement, which occurred at 50 miles from the coast, the chase ended and the defense squadron returned to the northward; Admiral O'Neill's division continued to the south.

Thus, on the first day of hostilities, Cette, Marseilles, Bandol, and La Ciotat were captured or bombarded, and the strategic railway along the Mediterranean was severed.

At 9 o'clock next morning (3d) the semaphores signaled that a hostile squadron was approaching Cette from the westward. Admiral Alquier hastened to its assistance, leaving the *Duperré* and *Duguesclin* to protect Marseilles, especially from the *Courbet*. At the same hour Admiral O'Neill learned from his scouts that the defense squadron was en route to Cette. His ruse had succeeded; he stood in and bombarded Bandol a second time, and then appeared before Toulon, which was defended by torpedo-boats alone. As his adversary could not arrive for seven hours, Admiral O'Neill bombarded the city and at 6 p. m. its destruction was considered complete; at the latter hour Admiral Alquier reached Cette to find that it had been threatened by the *Seignelay* and *Dragonne*, which fled on his approach.

At dark the Second Squadron put to sea, standing to the southward from Toulon.

Admiral Alquier, leaving Cette, steered during the night for Marseilles.

During this night, also, the *Coureur* succeeded in deceiving the scout of the *Duperré* and *Duguesclin*, and entered the port of Joliette before being seen by the signal stations.

At 11 p. m., however, the movements of the attacking squadron were interrupted by a collision between the *Courbet* and *D'Estrées*. Four vessels were proceeding in line abreast, at slow speed. The *Courbet* signaled a change of course, which, perhaps on account of the light mist, was not understood by the *D'Estrées*. The latter vessel had to go into dock.

By the morning of July 4, Bandol had been bombarded a second time, Toulon was destroyed, the defense squadron was off Marseilles, and the enemy was cruising off-shore. In the afternoon Admiral O'Neill attempted an attack on Port-de-Bouc, but the defense arrived and he withdrew, pursued by the former. But a mistral coming up, the chase had to be abandoned. Admiral O'Neill's division arrived at Cette the next morning at 6, and, after bombarding it, stood to the eastward for the Hyères Islands, where, upon arrival, an attack, followed by a landing, was made successfully at Porquerolles, and torpedoes were laid in channels through which the defense vessels might pass. Early on the 6th the latter reconnoitered the coast east of Toulon. At this time their adversary was off Sablettes, nearly due south of Toulon. Nor was he seen by other vessels of the defense, manœuvring at the same hour off Marseilles. At 11 a. m. the Second Squadron attacked Salins d'Hyères, 10 miles east of Toulon, but met with no resistance.

At 5 p. m. the First Squadron returned to Toulon, and was followed an hour later by the Second. The first series of manœuvres had ended.

These operations emphasize the advantage of the attack over the defense. Admiral O'Neill succeeded in most of his attempts, notably before Marseilles and Cette. A study of the rules will show that the defense could not make a detachment without exposing itself to defeat in detail; and, in fact, Admiral Alquier could only send away two battle-ships, the *Amiral Duperré* and *Duguesclin*, when he was certain that his adversary had detached the *Courbet* to operate from Marseilles to Bandol. Thus the defending squadron was forced to remain massed; its inferiority in speed prevented it from assembling at a threatened point before the enemy had done serious damage; the number of its scouts was insufficient to keep informed of the adversary's movements and to form an unbroken chain of communications. Besides, two of its scouts had to enter Toulon to repair their boilers. This deficiency in reconnaissance power rendered Admiral Alquier's task the more difficult. He therefore limited his objective to the protection of the Marseilles-Toulon line, and left Cette to the four torpedo-boats.

The defense had the advantage of detaching its vessels one by one to Marseilles and Toulon for supplies, especially coal. This advantage was not enjoyed by the enemy, as long as it had to fear an attack. Superiority in speed is therefore deprived of its full advantage unless supplemented by a coal supply.

SECOND SERIES.

During the second series of manœuvres, which opened on the 23d of July, the rôles of the two rear-admirals were reversed and the composition of the two squadrons was not the same as during the first. It was as follows:

FIRST SQUADRON.

Rear-Admiral ALQUIER, commander-in-chief.

Dévastation, *Amiral Baudin*, *Courbet*, *Redoutable*, *Amiral Duperré*, and *Formidable*, battle-ships.

Seignelay and *Inconstant*, unprotected cruisers.

Bombe and *Flèche*, torpedo vessels.

Coureur, *Déroulède*, *Doudard de Lagrée*, *Cuny*, and *Challier*, deep-sea torpedo-boats.

This squadron formed two divisions.

SECOND SQUADRON.

Rear-Admiral O'NEILL, commander-in-chief.

Vauban, *Duguesclin*, and *Bayard*, armored cruisers.

Condor, protected cruiser.

Papin, unprotected cruiser.

Corse, armed dispatch vessel.

Dragonne, torpedo vessel.

Balny and *Mehl*, deep-sea torpedo-boats.

The problem of the manœuvres was the capture of Porquerolles, the most westerly of the Hyères Islands, and of the port of Toulon.

The entire defensive force consisted of the Second Squadron, stationed at Toulon, nineteen torpedo-boats and of the batteries in the Hyères Islands. The latter command the roadsteads of Salins, Badine, Léouble, and Bormes, and the Giens Channel, which connects Toulon with Hyères Bay.

Two hundred men formed the garrison of Porquerolles; they were divided into four groups of fifty men each, at different stations. To approach an equality with the entire landing force of the First Squadron, each group of five was supposed to represent fifty men. So that if a landing party of fifty men were opposed by a single group of five, it should retreat; but two hundred men once landed could not be opposed successfully by less than four groups or twenty men.

The general defense was commanded by Vice-Admiral Duperré; the mobile defense was under Rear-Admiral Augey-Dufresse; the fixed defense under Captain Blanc, director of the port, and the troops under Rear-Admiral A. Parrayon, major-general.

At 8 a. m., on the 23d, the First Squadron put to sea from Toulon, and spent the forenoon in exercises and preparation for attack.

The fixed defense of Toulon meanwhile laid out submarine mines and got cables across the channels to the harbor.

About 1 p. m. the hostile fleet was sighted in the offing; the cruisers of the defense squadron took position well out in Toulon roads, and the torpedo-boats in two divisions were stationed, eleven in the inner harbor and eight in the outer.

The *Duperré* and *Redoutable* and the majority of the cruisers and torpedo-boats of the attack stood towards Toulon, the remainder of the vessels heading for the Hyères group. About 6 p. m. a general attack of the coast began. A hostile torpedo boat, taking advantage of a skirmish to the westward of Toulon entrance, steamed alongshore, entered the roads, and tried to blow up the *Duguesclin.* Discovered just as it cleared the break-water, it was attacked by the torpedo-boats of the defense and forced to withdraw. During this time the vessels sent against the Hyères batteries by Admiral Alquier bombarded Bregançon, Léouble, Gien, and Porquerolles. Landings were made at three points on Porquerolles in the face of the defenders and the island captured.

Meanwhile the armored vessels of the defense remained quietly at anchor inside Toulon Harbor, with the channel defended against torpedo boats. After the capture of Porquerolles the *Dévastation*, *Baudin*, *Courbet*, and *Formidable* cruised in the vicinity and the *Duperré* and *Redoutable* off Toulon. The two latter attempted the entrance of Toulon channel, but were discovered by the battery search-lights.

Informed of these movements, Admiral O'Neill towards 10 p. m. sent out all his torpedo-boats to drive them off. One group of four boats ran to the eastward and succeeded in launching a torpedo under the *Redoutable;* a second group, led by the *Corse*, blew up the *Duperré ;* the third flotilla, grouped about the *Condor*, stood first to the westward and then to the southward, and finally, steering towards Porquerolles, fell successively upon the four battle-ships in the main channel and torpedoed them at ease. Not one escaped.

In the darkness and without running-lights, Nos. 64 and 38 collided; they had attacked the *Amiral Baudin* together, one to starboard, the other to port. After firing their torpedoes they dropped astern of the battle-ship. No 38 was running at full speed, when her commander saw No. 64 ahead. He stopped and reversed but not without colliding

Almost at the same time No. 33, which had attacked the *Duperré*. was trying to join the *Corse* group and found herself suddenly under, the rays of a search-light. Blinded, she struck No. 39, but happily at low speed.

The Marine Française, of August 8, 1889, states that in the open daylight of this attack a torpedo-boat of the hostile squadron cut a rope hawser across the Toulon Channel, entered the harbor, and torpedoed the *Bayard.* This statement is not confirmed by other journals. The attacking squadron defeated, the manœuvres ended. The value of the torpedo-boat in night attack is very clearly demonstrated by these operations. They also show that the simplest and most effective adjunct to port defense is the search-light in sufficient number to illuminate the entire approach.

THE CHANNEL MANŒUVRES.

During the operations in the Mediterranean, others were taking place off Brest and Cherbourg between the Channel Squadron as the defense and another mobilized for the attack.

The following General Idea was adopted:

(1) A squadron from the east seizes a position on the coast as a base for landing. The torpedo-boats of the Cherbourg mobile defense attack it at anchor. The expeditionary force lands, however, but is forced by the garrison to re-embark.

(2) Operations against Cherbourg.

The channel or defense squadron, Rear-Admiral Planche, commander-in-chief, was composed of the *Tempête* and *Tonnant*, coast-defense vessels; the *Grenade*, armored-gun vessel, and eight torpedo-boats.

The second or attacking squadron, Rear-Admiral Boussidy, commander-in-chief, comprised the *Marengo*, *Océan*, and *Suffren*, battleships; the *Sfax* and *Epervier*, protected cruisers; the *Ibis*, dispatch vessel; and torpedo-boats No. 70 and *Dehorter*.

The latter squadron left Havre early on the 2d of July, and a few hours later anchored in La Hogue Roads, capturing its port, Saint-Vaast, without firing a shot. In the afternoon it made preparations to resist the defense arriving from Cherbourg.

Informed that its adversary had occupied Saint-Vaast Roads with the intention of making it a base against Cherbourg, the defense squadron got under way at 7.30 p. m. of the same day for that point.

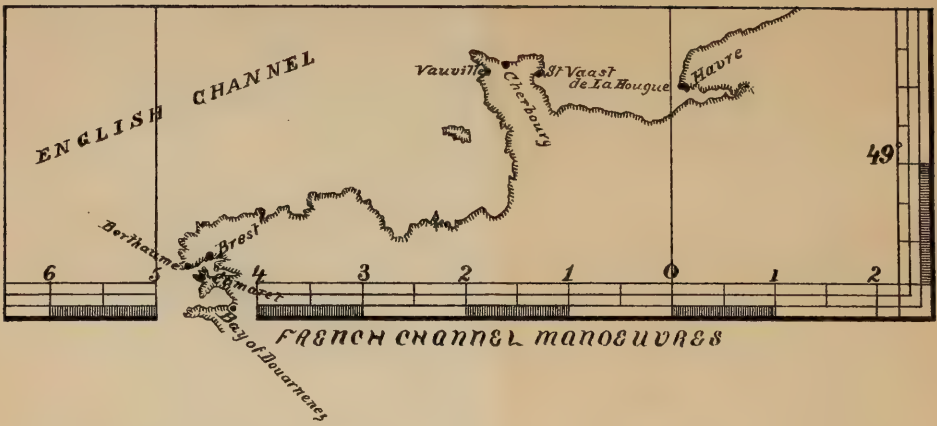
The night was dark and a fresh breeze was blowing; the vessels at La Hogue exhibited no lights.

The defense squadron arrived at 1 a.m. and threw its torpedo-boats, divided into three groups, on the hostile ships, guarded by scouts. Torpedo-boat No. 54 passed the line of the outer lookout ships, but collided with the *Dehorter*. Both were without lights, No. 54 going from 14 to 15 knots; the damages were not serious. Two other torpedo-boats were discovered and fired on; but the remaining five arrived within 200 metres of the *Marengo* and *Suffren* without discovery and burned blue lights to indicate that they could launch their torpedoes with success. The engagement ceased at 2.30 a. m. The defense returned to Cherbourg.

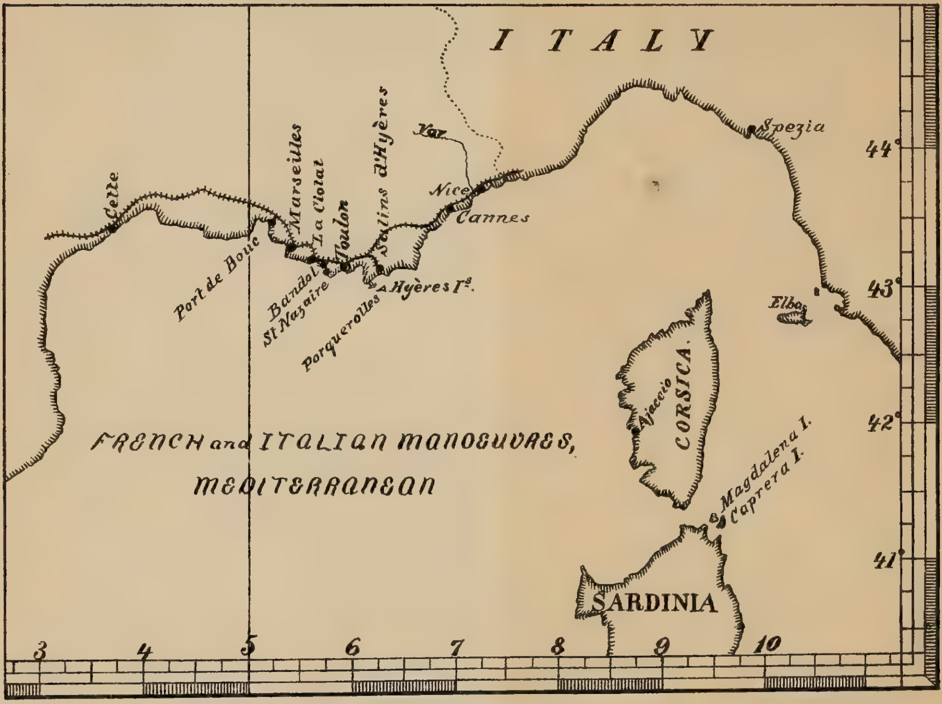
On the night of the 4th, the hostile squadron appeared off Cherbourg; the forts were manned in readiness for attack, but this movement of the adversary was simply a demonstration.

On the 5th, the plan supposed a landing on the coast and the capture of a base against Cherbourg. This operation was attempted at Vauville, about 9 miles west of Cherbourg, and opposed by the garrison which forced the naval brigade to re-embark.

The details of these operations have not appeared in print.



FRENCH CHANNEL MANOEUVRES



FRENCH and ITALIAN MANOEUVRES, MEDITERRANEAN

SECOND SERIES.

The second series of manœuvres opened on the 22d, the formation of the squadrons remaining unchanged.

The squadron of attack anchored during the day in the Bay of Douarnenez, the *Suffren*, *Marengo*, *Océan*, and *Sfax* being on a bow and quarter line. The three channels leading to the anchorage were protected by booms or by patrol launches. The mouth of the bay was watched by the *Epervier* and *Ibis*, and a torpedo-boat, lookout vessels.

The weather was dark and favorable for attack.

The defense squadron left Camaret, near Brest, and reached Douarnenez Bay after dark. The *Tempête*, *Tonnant*, and *Grenade* remained in the offing, while the light torpedo-boats, operating in pairs, attacked their opponents. Press dispatches state that one torpedo-boat got under the stern of the *Epervier* unseen. Another arrived at a short distance from the *Océan*, having eluded the lookout ships. The attack claimed that seven of the torpedoes fired would hit the adversary's vessels. The latter deny it; but there seems no doubt at all that the torpedo-boats made a most successul attack against the supposed enemy, who had anchored in an open roadstead.

These operations were repeated next day, increased precautions being taken against torpedo-boat attack; at their conclusion, the Defense Squadron returned to Brest.

At noon on the 25th, the hostile squadron attacked the forts and batteries at Brest. The *Tempête*, accompanied by the *Grenade*, as scout, and four torpedo-boats, was stationed in the outer roadstead (Berthaume Bay), the remainder of the squadron being in the entrance to the inner harbor.

At 1 p. m. the three battle-ships of the attack forced the channel, made a tour of Brest Roads, and then left to take position for the night attack.

At 10 p. m. search-lights on shore were directed upon the approaches, along with those of the defense division. The firing began half an hour later. During the attack the *Epervier* passed the entrance without being seen; the torpedo-boats of the defense attacked the hostile battle-ships.

At midnight both squadrons anchored in the roadstead. The manœuvres here ceased.

No detailed account of the operations of the 23d and 25th has been made public.

COMMENTS.

The low speed which the armored ships were required to maintain gave but little chance of accident to their machinery. The results were not so satisfactory in the rest of the fleet, which could develop nine-tenths of its speed. The torpedo vessels appear to have suffered the greatest damage to their machinery, though they were not taxed to their utmost. As pointed out, two of them had to return to Toulon with their boilers broken down. The machinery of cruisers drawn from the reserve suffered from the comparative inexperience of a personnel embarked in haste to complete the engine-room complements.

The vessels of the north coast manœuvres were drawn chiefly from the reserve; though they were ready as to material, the operations developed the fact that they were not so in personnel and so far were defective war weapons.

During the night of the 5th of July, on the coast of Provençe, a west-northwest breeze blew, followed by a moderate sea. The larger ships were not affected by it, but the smaller torpedo boats had to seek an anchorage and the deep-sea torpedo boats kept under the lee of the battle-ships. Neither were able in consequence to act as scouts during this wind, and had the attacking squadron come up they would have remained powerless spectators of the action. These facts confirm the lesson of the English manœuvres, that the size of torpedo vessels and boats should be increased as much as practicable; and that the present types are useless in rough weather.

The torpedo boats were forced to retreat in open day before the secondary batteries of battle-ships and other large vessels; but, under cover of darkness, they pursued the adversary and fought him with remarkable success. Night seems an indispensable aid to the torpedo boat, which these manœuvres emphasize as a weapon of surprise, and a valuable arm against large ships and for coast defense.

As was to be expected, some controversy arose between the attack and defense about the success of torpedo operations. The officers in command of the boats claimed they could have fired their torpedoes; their adversaries deny it, on the ground that wind and sea would have rendered the launching of such missiles extremely difficult. The question is further complicated by the absence of the umpire's decisions; but the weight of evidence, so far as published, is unquestionably in favor of the torpedo boats.

Service in them was exceedingly trying on both officers and crew. On their return to Toulon, after five days' service, the commanding officers were exhausted, having had only a few hours' sleep; they had believed themselves able to remain awake night and day, but the strain was too severe for men of their age. The need of relief crews was shown most forcibly.

The Toulon manœuvres developed especially the importance of protected cruisers of the highest speed, as a factor in the composition of a fleet. The defense squadron, lacking in them, suffered a great disadvantage through its inability to watch the enemy, to collect intelligence, and to maintain its lines of communication.

The personnel of the fleet was not sufficient in numbers and the reserve quota showed a lack of drill. Even this short test demonstrated that officers and men of the reserves should be well drilled, and that the cadres of each should be sufficient for all emergencies.

The manœuvres also strengthen the theory that coast defenses should not be scattered at random, but concentrated at points only where an enemy would have a genuine interest in making a descent, and that where the mobile defense of a littoral zone is limited to coast-defense vessels and torpedo boats, protection against a fleet of powerful battle-ships will be in vain.

GERMANY.

A manœuvring fleet, a squadron of evolutions, and one of armed gun vessels assembled this year in the Baltic and the North Seas.

The manœuvring fleet, or first division, commanded by Rear-Admiral Von Kall, consisted of the barbette battle-ships *Baden*, *Bayern*, and *Oldenburg*, of the protected cruiser *Irene*, under Prince Henry of Prussia, and the dispatch vessel *Wacht*. It assembled on the 1st of May and remained on service till the 1st of October, manœuvring in the Baltic in combined operations with the marine infantry and detachments of the army, assigned to coast defense.

The squadron of evolutions, commanded by Rear Admiral Hollman, consisted of the turretted battle-ships *Kaiser*, *Deutschland*, *Friedrich der Grosse*, *Preussen*, with the armed dispatch and torpedo vessels *Zieten* and *Blitz*, and two flotillas of torpedo boats. Each flotilla was composed of one torpedo vessel of 350 tons and eight torpedo boats of 85 tons each. This division assembled during May in the Baltic and operated against the first division.

The third division consisted of four armed gun vessels of the *Wespe* class, under Captain Von Shukmann; it assembled on the 13th of August and manœuvred for one month in the North Sea, exercising in attack and defense of coast between Wilhelmshafen and Kuxhafen.

ITALY.

Twenty-four torpedo-boats were commissioned for the summer manœuvres, and divided into groups of four boats each; they were manœuvred generally in pairs, a certain liberty of action being allowed each boat. Each pair was attached to one of the larger vessels of the squadron, and was dependent upon it for supplies and repairs.

In squadron sailing or evolutions the two boats kept position on the quarters of the parent-ship; their station in action was on her lee or farther side, till a favorable moment to dart out under cover of the smoke and attack.

The torpedo-boat exercises comprised day and night attacks.

DAY ATTACK.

In these operations the General Idea was that twelve torpedo-boats were to gain position on an imaginary circle about a battle-ship or cruiser, using a radius of 3,000 metres to avoid her rapid-firing guns and then to steam for the vessel at full speed, discharging the torpedoes when at 400 metres distance. The latter, meanwhile, was to manœuvre to prevent the boats from surrounding her.

It was very difficult to accomplish this operation, but in some instances the boats were successful.

No other form of day attack was regarded as practicable because of the certainty of destruction by rapid-firing guns before a torpedo could be launched.

As stated, however, the torpedo-boat was utilized by day, when in company with a larger vessel and hidden by it up to the moment of attack.

NIGHT ATTACK.

(*a*) Six torpedo-boats were directed to cruise in pairs and search for a vessel at anchor between certain limits of the Sardinian coast—a shore line broken by many bays, inlets, and islands. Discovery was followed at once by attack; a buoy was dropped and a blue light burned when the torpedo was discharged. On the following morning, the buoy's position was verified to determine the distance from the vessel.

(*b*) The fleet of larger vessels, with all lights extinguished, passed from the Maddalena to Spezia. One-half of the torpedo-boats were stationed between Capraia and Elba; the other half near Corsica. The sea was very rough and the boats were well hidden by the waves; they were thus enabled to approach and strike the *Italia*.

In these manoeuvres the search light was not used; it was regarded as an assistance to the torpedo-boats and of no advantage to the defense

In night-firing, however, it was used with satisfactory results, the light being thrown from the ships upon the shore targets.

RUSSIA.

The Russian manœuvres were held in the Gulf of Finland, beginning on the 11th of August at Sveaborg, the strong fortress which defends the entrance to the port Helsingfors. Concluded there on the 15th they were resumed at Cronstadt on the 21st of August and came to an end on the 28th following.

The fleet was divided into two squadrons as follows:

FIRST SQUADRON.

Vice-Admiral KOPYTOV, commander-in-chief.

Peter Veliki, battle-ship.
Admiral Spiridoff, *Tcharodéika*, coast-defense vessels.
Herzog Edinburgski, armored cruiser.
Vestnik, *Plastoun*, *Opritchnik*, *Strelok*, unprotected cruisers.
Lieutenant Iljin, torpedo vessel.
Slavianka, screw schooner.
Ilmen and *Rabotnik*, transports, and four torpedo-boats.

SECOND SQUADRON.

Vice-Admiral SCHWARZ, commander-in-chief.

Latnik, Bronenosetz, Streletz, Perun, Vaichtchun, coast-defense vessels.
Burya, Groza, Dojd, Vikr, Burun, and *Snieg*, gun vessels.

The chiefs of squadron reported secretly their plans of operations to Vice-Admiral Pilkin, the umpire, who was assisted by Captain Hildebrand for the First Squadron, which represented the attacking force, and by Captain Skrydlov, representing the Second Squadron, or defense.

The squadron of attack occupied the Gulf of Riga as a base, from which it conducted the blockade at Sveaborg of the weaker defending force. The latter harassed its adversary by a series of day and night attacks, raised the blockade, forced the hostile squadron to withdraw after having bombarded the city, and left the port to attack it at sea.

On the 21st the defense squadron was at Cronstadt, and that of attack occupied a position which commanded the line between Krasnaïa, Gorka, and Strisonden, and where it could land troops to attack St. Petersburg. It bombarded the arsenal, docks, and ships in the port of Cronstadt. Unable, in spite of counter-attacks, to prevent these movements, the second squadron retreated under the guns of the fortress.

The smaller vessels of the First Squadron sought then to force the south channel to Cronstadt, which is defended by batteries. This operation being unsuccessful they withdrew, and at night a landing was attempted against the defenses of the same channel. This attack failed also. The passage of the main channel was then attempted by the entire squadron; driven back, it put to sea to make repairs, and returned to force the passage of the north channel. Informed of these movements by its scouts and the signal stations, the Second Squadron was able to repel all attacks and drive the assailants again to sea.

The operations were then concluded.

AUSTRIA.

The fleet manœuvres for 1889 were divided into two series.

The squadron for the first series was organized as follows:

Admiral STERNECK, commander-in-chief.
Rear-Admiral SPAUN, second in command.

Dispatch vessel: *Greif* (flag of admiral).
Battle-ships: *Erzherzog Albrecht* (flag of rear-admiral), and *Custozza.*
Armored cruisers: *Prinz Eugen, Don Juan de Austria.*
Partially-protected cruiser: *Leopard.*
Torpedo vessels: *Blitz, Komet*, and *Meteor;* four torpedo-boats.

The manœuvres were held at Trieste, and consisted chiefly in the trial of a system of tactics proposed by Lieutenant Labrés. Its principal feature lies in the abolition of the old line of battle, and, instead, the division of the fleet into groups of four vessels in echelon, the ships being near enough together for common support.

The second series of the summer programme was held on the Dalmatian coast, Rear-Admiral Spaun being commander-in-chief.

The general organization of the squadron was the same as during the first series. The *Greif* was withdrawn; the *Tiger* took the place of the *Leopard*; the torpedo depot ships *Cyclops* and *Kaiserin Elizabeth* were added; and the number of torpedo-boats was increased to eighteen.

The exercises consisted principally of attacks on the coast, during which the armored vessels acted as a covering squadron; and in night attacks on the larger vessels by the torpedo-boats.

VI.

NOTES ON THE RECENT NAVAL MANŒUVRES.

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[Paper read at the thirty-first session of the Institution of Naval Architects.]

The council of the institution, finding themselves less favorably placed than in former years in relation to papers offered for reading and discussion urgently requested me to contribute to the programme of the present meetings. Under existing circumstances, as will be readily understood, compliance with this request was for me no easy task, especially as the notice has been so short. Moreover, after the very large amount of time given last year to the discussion of my paper "On the New Battle-Ships," I should have preferred leaving to other members the opportunity of giving direction to our discussions.

Yielding to representations that the interests of the institution would be best served by compliance with the request of the council, my difficulty was to select a subject of general interest, which could be treated with some approach to completeness in the very limited time available. Finally, I decided to place before the institution these "Notes on Recent Naval Manœuvres," dealing with some important matters which have already been made the subject of discussion and criticism in the public press or elsewhere, and respecting which there seems room for further explanation or illustration. My chief aim in writing this paper has been to deal chiefly with facts and to provoke discussion.

Members of this institution are aware that at the request of the First Lord of the Admiralty I went afloat last August and remained with the fleet during the manœuvres. Excellent opportunities were thus afforded me for observing the operations of mimic warfare and fleet manœuvring; and we had the good fortune during a considerable part of the time to experience weather of exceptional severity for the season of the year, so that it was possible to make useful notes of the behavior of ships of various types. My interest naturally centred in matters affecting or related to my professional work as the responsible designer of H. M.'s ships; and in what follows I shall endeavor to place before the institution certain broad deductions which have impressed themselves on my mind, and certain opinions previously held, which have been deepened as the result of my brief cruise with the fleet.

I. THE INFLUENCE OF SIZE AND WEIGHT UPON THE SEA-GOING QUALITIES OF SHIPS.

This matter was discussed at some length at our meetings last year, in connection with papers read by Sir N. Barnaby and myself. It also occupied a prominent position in the discussion following upon a paper read by Sir N. Barnaby before the Institution of Civil Engineers. It would appear, however, that there is room for further consideration of the question.

The point here raised is not the absolute behavior at sea of ships of different sizes and weights, but their relative behavior, under identical conditions of wind and sea. Consequently a judgment can only be formed by comparing the behavior of ships of different sizes navigating together. And the comparison is made most valuable when a fleet includes vessels of widely divergent dimensions, with the gradations of size, from the smallest to the largest represented at fairly close intervals. Probably the manœuvres of 1889 fulfilled these conditions better than any previous assemblage of ships. Beginning with the *Inflexible*, of nearly 12,000 tons, by successive steps, one could pass down to the torpedo gun-boats of about 500 tons, and torpedo-boats of less than 100 tons. Table A shows this at a glance.

While recognizing the comparatively limited scope of the observations possible during the manœuvres, it is undoubted that every one who saw these ships under circumstances of bad weather must have been impressed with the superior behavior and fighting qualities possessed by the larger vessels as compared with the smaller, when other features—such as freeboard and height of guns above water—were similar in the ships of differing sizes. Reference will be made hereafter to the influence of freeboard and disposition of armament on fighting efficiency. But dealing simply with weight and length as elements influencing the behavior and the maintenance of speed at sea it may unhesitatingly be asserted that increase in size has a most marked effect in improving sea-going qualities.

This may seem a mere truism, but there is a special reason for dwelling upon it. There is a general agreement that up to certain limits increase in size results in considerable advantages. But it has been maintained by some authorities that beyond a certain limit of size, and that not very considerable, these advantages become relatively less important. For instance, Sir Nathaniel Barnaby last year made the following remarks (at the Institution of Civil Engineers), when advocating the construction of vessels of 3,000 to 3,500 tons displacement for service on the line of battle:

> It was said that the ship of 3,000 tons was very small. His object in advising those who prepared the design was to keep to a ship of minimum size for doing the work.

That a ship could be made larger with advantage was no doubt true; but he thought the ship in question fairly balanced all the qualities that could be got in a ship of the smallest size, capable of fighting an action at sea. * * * He agreed with those naval officers who thought that any weather which would sensibly affect the comparative behavior of the ship of 3,200 tons and that of 14,000 tons, would be found to be not fighting weather for either ship.

TABLE A.—*List of vessels engaged in the naval manœuvres of* 1889, *arranged in order of displacement.*

Ship.	Displacement.	Length.	Ship.	Displacement.	Length.
	Tons.	*Feet.*		*Tons.*	*Feet.*
Inflexible	11, 880	320	Hotspur	4, 010	235
Northumberland	10, 780	400	Iris and Mercury	3, 730	300
Admiral class	10, 600 to 9, 500	325	Active and Volage	3, 080	270
			Medea class	2, 950 to 2, 800	265
Devastation	9, 330	285			
Neptune	9, 310	300	Calypso	2, 770	235
Black Prince	9, 210	380	Ruby	2, 120	220
Hercules	8, 680	325	Archer class	1, 770	225
Ajax	8, 660	280	Hearty	1, 300	212
Warspite	8, 400	315	Nymphe	1, 140	195
Monarch	8, 320	330	Curlew	950	195
Northampton	7, 630	280	Pheasant class	755	165
Audacious class	6, 910 to 6, 010	280	Traveller	700	161
			Watchful	560	135
			Rattlesnake class	525	200
Hecla	6, 400	392	Medway class	363	110
Conqueror and Hero	6, 200	270	Torpedo-boats	137 to 28	150 to 86
Inconstant	5, 780	337			
Belted cruisers	5, 600	300			
Rupert	5, 440	250	*Coast-defense vessels.*		
Shannon	5, 390	260			
Belleisle	4, 870	245	Glatton	4, 910	245
Leander class	4, 300	300	Prince Albert	3, 880	240
Mersey class	4, 050	300	Cyclops class	3, 560	225

The great majority of naval officers with whom I have discussed this matter differ entirely from Sir N. Barnaby, and, as I think, with good reason. Even the limited experience of the recent manœuvres proves that for fighting in a seaway ships of 3,000 tons and upwards are not practically on an equal footing. "Fighting weather" at sea is not a fixed or determined quality for ships of 3,000 tons and upwards. The possibility of any ship continuing to fight and maintaining speed depends largely upon her length and size, as well as upon her freeboard and the disposition of her armament.

No one doubts that ships of 3,000 tons, or even of much smaller displacement, may be perfectly safe and seaworthy in any weather, and may be capable of fighting in bad weather. The vessels of the *Medea* class, for example, proved good sea boats; and as they carry two-thirds of their heavy armament on long poops and forecastles about 20 feet above water, it would be very bad weather that placed them entirely *hors de combat*. At the same time it was obvious when they were seen in rough weather alongside a belted cruiser of 5,000 tons, or the *Warspite* of 8,400 tons, that these latter had very superior powers of maintaining speed and fighting because of their greater size and weight. And if there had been present one of the new battle ships of 14,000 tons her advantages relatively to the *Warspite* would probably have been no less marked.

Experience shows that even in a very moderate sea torpedo gun-boats can run down torpedo boats which in dead-smooth water would "show their heels" easily. Similarly as the sea rises it would be practically impossible to continue to drive a torpedo gun-boat at anything like full power; considerations of safety would lead to the speed being eased down, under conditions when vessels of larger size (like the *Medeas*) could maintain their speed. But these, again, would have to be eased long before the *Warspite* would require to be similarly treated; and if the *Northumberland* possessed the requisite engine power she would in her turn surpass the *Warspite*, because of her greater size and length.

Similar remarks, *quâ* size, would apply to relative steadiness of platform and power of fighting the guns, if the armaments were similarly disposed; but these need not be amplified.

In speaking thus I do not desire to ignore the well-known fact that under certain conditions of sea larger and longer ships may pitch or roll more heavily than smaller ships. I am dealing not with such exceptional circumstances, but with ordinary or average occurrences. At the same time it may be interesting to add that during the manœuvres I repeatedly noted heavier pitching in the *Warspite* and *Black Prince* than was occurring simultaneously in vessels of the *Medea* class. Occasional heavy rolling of large ships has also been noted under conditions when smaller ships were comparatively steady. These exceptions will not, I think, shake the opinion of most naval officers that the largest ship is, for sea work, the best.

"Fighting weather" is a very elastic term. Modern appliances have done much to extend its meaning. I may mention one example. In the *Howe*, when placed intentionally beam-on to a heavy sea, and with the ship rolling through arcs of 35° to 40° every five and one-fourth seconds, the after turntable carrying two 67-ton barbette guns was cast loose and the guns successfully worked. Even under these conditions the ship could have been fought; but it is doubtful if a smaller ship would have been as well placed under the circumstances.

It will be noted that reference has been made chiefly to weight and size, but I am not oblivious of the great influence of length upon the maintenance of speed at sea. It is well known that in all recent designs for H. M.'s ships greater lengths have been accepted in proportion to displacement than have ordinarily been adopted. For example, the *Edgar* class of cruisers will have a length of 360 feet for a displacement of 7,700 tons, as against 315 feet for 8,400 tons in the *Warspite.* The *Apollo* class of cruisers are 300 feet in length for 3,400 tons displacement, as compared with the same length for 4,050 tons in the *Mersey* class. This increase in length naturally arises from the high speeds aimed at in recent designs, and it will undoubtedly add to the power of maintaining speed at sea. Still greater relative length has been given to some foreign cruisers, which, as a rule, are more lightly armed than H. M.'s ships, and can therefore be constructed of different proportions. And in the mercantile marine where the vertical distribution of weights is altogether different from that in war-ships, still greater relative length and narrowness are common; but it is the element of absolute lenght and not ratio of length to beam which is of the highest importance for maintenance of speed at sea.

This audience is well aware of the fact that the first-class passenger steamers of the first rank greatly exceed, in displacement as well as length, even the largest cruisers yet constructed (H. M. S. *Blake* and *Blenheim*). On this account it is unreasonable to expect that any regularly built war cruisers yet contemplated can catch vessels, like the *City of Paris*, or *Teutonic*, or *Umbria* at sea. Moreover, in these grand steamers the ratio of load carried—exclusive of hull fittings and propelling apparatus—to total displacement is altogether different from the corresponding ratio in the war cruiser. In fact, they are designed for entirely different services and can not well be compared.

It has been proposed that war cruisers should be built equaling these "greyhounds" in speed and coal endurance, but surpassing them in armament and protection. To do this must involve still greater displacement and cost; and one may well hesitate in embarking on such a course, so long as we possess not merely a vast superiority in swift merchant steamers available as auxiliaries to the regular fleet, but also larger war cruisers than are to be found in foreign navies.

In concluding my remarks on this section, let me say that, while I most strongly maintain the opinion that increased size and weight give great advantages in the maintenance of speed, steadiness of gun platform, power of concentrated attack and superior defense, I also hold that in the Royal Navy there is not merely room, but a positive necessity, for vessels of widely differing sizes and types. Furthermore, there is a consensus of opinion that no small proportion of our total force, particularly in the cruiser classes, should be of moderate size and cost, in order that a considerable number of vessels may be available without an inordinate outlay. For sea work and the line of battle, however, there seems good reason for the opinion generally held in the naval service that ships of large size are absolutely necessary; while the conditions under which our ships have to serve, more particularly as regards coal endurance, practically necessitate that in any special class the British ship should be of greater dimensions than the foreign ship she may have to encounter.

II. THE INFLUENCE OF FREEBOARD, HEIGHT OF GUNS ABOVE WATER, AND DISPOSITION OF ARMAMENT UPON FIGHTING QUALITIES AT SEA.

The fleet mobilized for the manœuvres last year contained specimens of most of the classes of armor-clads and cruisers built during the last twenty-five or thirty years. Some of the latest constructions—such as the barbette ships of the *Admiral* class, the belted cruisers (*Orlando* class), and the protected cruisers (*Mersey* and *Medea* classes)—were in company with grand examples of the earlier iron-clad period, the *Northumberland* and *Black Prince*, with broadside ships of later date (such as the *Hercules*, *Northampton*, and *Audacious*), with turret ships of high and low freeboard, and with unarmored cruisers possessing good sail power as well as steam.

It was possible, therefore, to make very interesting comparisons of fighting efficiency.

Taking first the question of freeboard, one could compare:

(*a*) Ships of high freeboard throughout the length.

(*b*) Ships of moderate or low freeboard at the extremities, and high freeboard amidships.

(*c*) Ships of moderate or low freeboard at the fore end, but high freeboard for a portion of the length to the stern.

(*d*) Ships with long poops and forecastles, with moderate freeboard between.

(*e*) Ships with low or moderate freeboard throughout the length, with "flying structures" amidships for stowage of boats and other services.

Speaking broadly, the experience of August last confirms the conclusion generally reached beforehand, viz., that low free board forward puts a practical limit upon the power of driving ships against a head sea, while it entails a sensible increase in the expenditure of power required to maintain a given speed in a moderate sea, as compared with the expenditure in high-ended ships of similar form and equal size.

Lowness of freeboard aft is, of course, less important; but there were times during the manœuvres when the low after ends of the *Admiral* class, and of certain turret ships, were clean swept by the sea, and when a greater freeboard would have been advantageous, especially as regards habitability and comfort.

Lowness of freeboard throughout the length (as in *Devastation* and *Rupert*) necessarily intensifies discomfort and reduces sea-keeping qualities.

High ends, associated with moderate freeboard (or a "waist") amidships, give good living quarters and an increased power of driving-head to sea; but while it admits of a smaller and cheaper ship being built to fulfill fixed conditions of speed, coal supply, armament, and protection, it entails some sacrifices in the way of "wetness" and discomfort when hard driven, as compared with vessels equally high-ended, but with a complete spar-deck. Every one who saw the vessels of the *Mersey* class, for example, when hard driven in rough water, must have regretted that they were not built as first designed, with a flush upper deck. The *Warspite* and belted cruisers furnished good examples of the advantages of such a flush-deck when steaming head to sea.

It may be interesting to state, in passing, that the Admiralty have decided, largely as the result of experience gained with cruisers during the manœuvres, to construct a considerable number of the second-class cruisers, building under the naval defense act, with flush upper decks. This entails increase in size and cost, but will add to the sea-going and fighting qualities.

Turning to the closely related questions of the influence of height of guns above water, and their disposition upon fighting efficiency, very brief remarks may suffice.

It had been previously demonstrated that in thel ow freeboard turret-ships a moderate amount of sea made difficult or impossible the fighting of the forward turret-guns. Confirmation of this view was furnished in August last. Those who were present will not soon forget the contrast between the *Hero* plunging along towards Ushant against a long smooth swell (12 to 15 feet in height) with her foreward deck buried under masses of water, and her turret guns practically unworkable, and the other ships with guns placed higher, and perfectly capable of fighting. In the *Admirals* on that occasion, the low foreward deck was continuously buried under broken water, but the barbette guns (9 to 10 feet above the deck) were not affected. The *Melpomene*, rushing to the front in the chase—and placing herself in a position which in real warfare would have been certainly questionable—fought her 6-inch guns with ease, the *Hero* having no heavier gun to reply with. There were many other cases which might be mentioned, illustrating the disadvantages of guns placed low, but to these I need not refer.

This same incident in the manœuvres may be used to enforce once more the undesirability of that extreme concentration of armament which deprives ships of effective stern-fire from heavy guns. The *Hero* has only one turret which could not be fought, and her pursuers had her at their mercy, as she could only bring one or two 6-inch guns to bear on them.

The *Inflexible* and *Ajax* represented the moderate freeboard central citadel ship with turrets, *en echelon*, placed close to the sides of the vessel. This arrangement is open to very serious objection, especially with long breech-loading guns; for even a moderate angle of roll or a moderate lift of the sea practically interferes with efficient fighting of the turrets, especially when trained nearly abeam.

Last year I sketched the reasons which have led to the very various dispositions of armament, as well as heights of freeboard and of guns above water, in modern warships. It is unnecessary to repeat what was then said. Further, it can not be doubted that, under other circumstances than fighting in rough water, there are compensating advantages in lowness of freeboard and of guns—particularly as regards diminution of target and of surfaces requiring protection. On the other hand, we have in the Royal Navy a very large number of ships of moderate freeboard, with guns at a small height above the decks; and in view of this fact it will be generally agreed that in building most recent ships with high freeboard, and guns placed at considerable heights above water, the Admiralty has done wisely, adding greatly to the power of our fleet, for what after all is its great necessity—fighting in the open seas.

Habitability, the power of maintaining speed, and of fighting in rough water, are all favored by good freeboard. After all has been said about fighting efficiency, habitability claims some attention. Comfort to officers and men under the ordinary every-day conditions of peace-service must not be ignored. A great deal of nonsense has been written and spoken on this subject; not a little by persons who clearly had no real acquaintance with the ships they decried. For instance, I have read severe strictures on the accommodation, ventilation, and living quarters on the *Admiral* class, for which there was no foundation in fact. One gentleman went so far as to describe the "pasty-faced" condition of the crew as obvious to the casual observer. He drew upon his imagination freely, and described a hypothetical deterioration that must have been wofully rapid—seeing that with the single exception of the *Anson*, none of the *Admiral* class was in commission more than two months, or at sea more than a month. Having lived on board one of the class for a month, and carefully inspected all parts of the vessel in all weathers, and at all times of the day and night, I emphatically deny the truth of these anonymous assertions. The living quarters for the crew are excellent in all respects—the officers have good accommodation. When battened down for several days the living spaces below the low ends are naturally not so fresh as when every hatch is open in harbor; but even to a landsman, like myself, there was nothing to seriously complain of, and my cabin at the extreme after end of the ship was probably least favorably situated. The crew were much better off than the officers when battened down, a very large part of them being berthed in the main-deck battery, where there was always good natural ventilation. Some increase in ventilation of the officers' quarters is admittedly desirable, and will be carried out, but no such change is needed in the crew space.

One inconvenience was suffered which has been much exaggerated. Certain minor defects of workmanship in the fittings on the low deck forward resulted in leakage of water into that portion of the crew space. The cables also were kept bent with anchors ready to let go. When the vessels were in rough weather, and the forward deck was continuously flooded, water did pass below and cause some discomfort; but these defects are easily remediable, and they will be remedied. It is well known that in the *Devastation*, when first sent to sea, the arrangements for water-tightness, when battened down, were not altogether satisfactory, but experience has removed all trouble, and so it will in the *Admirals.*

I may add that similiar misrepresentations have been made of the living quarters in the *Medea* class, which compare very favorably as a matter of fact, with those of any ships of equal size in the fleet. These quarters are situated, as already explained, in the high ends under poops and forecastles, with good natural light and ventilation; not a man being berthed over the machinery or boiler places.

Further, it may be interesting to state that in the *Polyphemus*, a vessel of altogether exceptional character and low freeboard, where dependence has to be placed on artificial light and ventilation, and which has had a considerable period of service in the Mediterranean, the health of the crew is found to be exceptionally good, thus disposing completely of the "pasty-faced" theory above mentioned.

III.—SEA SPEEDS AND MEASURED MILE SPEEDS OF WARSHIPS.

This is a very thorny section of my paper, but so much has been said and written on the subject of late that it can not be omitted. It seems probable that some public advantage may result, moreover, from the explanations I have to offer.

Members of this institution do not require to have any statement of the real purpose and use of measured mile trials. Still, it may be well to remark that they are designedly and avowedly made under the best possible conditions – engines and boilers in perfect order, the best coal, skilled stokers, calm weather, smooth water, and clean freshly painted bottoms. Only under these conditions can such trials be of service either for purposes of comparing ship with ship, or of yielding information which will be of value in future designs. For warships of all nations, moreover, this system of trial is established, and the recorded speeds are measured mile speeds.

In recent years Admiralty practice in the trials of H. M.'s ships has been varied considerably, and always in the direction of greater stringency. It is said, although I do not vouch for the statement, that formerly various devices were used, classed under the generic term "jockeying," which gave to the measured mile-results a character much beyond what was deserved, particularly as regards the development of power. Between the runs on the mile, steam was "bottled up" to be used during the runs, and on the mile the steam-blast was freely applied to increase development of power. If this were true in the past, it has long since ceased to be true.

In 1877 a regulation was laid down that, for the future, contractor's steam trials should extend over six hours' continuous steaming, the specified horse-power being attained as the mean of the power indicated over the six hours. When "forced draft" was introduced about seven years ago, the trials made with it were limited to three or four hours; the duration of natural draft trials remaining as before. About four years ago a further change was made, the duration of the natural draft trials being extended to twelve hours when the season of the year permitted. After considerable experience it was found that this was an inconveniently long time for trial, especially in the shorter days, and eight hours has now been substituted.

All these trials are now made, at least for a typical ship engined by each firm, at full load draught; and the ships often have to take on board large weights of ballast for the purpose of bringing them down. The engineer contractors have no responsibility for speed, but guaranty development of a certain power for a certain period, with a certain approximate number of revolutions.

Sometimes these contractors' trials are made without placing the ship on the measured mile, distinct progressive speed trials being made, especially with new types of ships, in order to construct curves of speed, power revolutions, etc. Then, knowing the revolutions and power obtained on the contractors' trial, the corresponding speeds can be determined from the curves. In other cases, during the contractor's trial, four or six consecutive runs are made on the mile to ascertain the speed. But the point on which I am now insisting is that the old practice of simply "running the mile" has long ago been abandoned, and that the speeds recently estimated as measured mile speeds for Her Majesty's ships are those corresponding to powers to be developed over eight or twelve hours with natural draft and three or four hours with forced draft. I much doubt if equally severe trials are made with the ships of any other navy.

Official records of speeds for Her Majesty's ships in the Navy Estimates and elsewhere have also for some years past given both the natural and the forced draft speeds. In the Navy List only the forced draft power is given.

Passing from these standard trial conditions to the conditions of actual service, every one having any acquaintance with the subject is well aware that there must be a considerable reduction made both in the powers developed and the speeds obtained. Engines and boilers will not remain in perfect order; coal is often of indifferent quality; stokers are not always equally efficient, nor can one expect from them over long distances work equal to that performed over a trial of a few hours; the bottoms of ships do not long remain clean, and it is rarely calm weather at sea. All these variable conditions affect actual performances at sea, and it is practically impossible to lay down any scale of even approximate reduction in order to connect smooth water or trial speeds with sea speeds for all classes and sizes of ships.

For years past, however, in Admiralty practice a rough rule has been followed, of which I have previously spoken here. It assumes that the maximum power likely to be developed continuously, for steaming at sea over long periods, will be not more than two-thirds, or less than one-half of the natural draft power developed on the contractor's trial. And further, recognizing the impossibility of making any constant allowance for foulness of bottom, roughness of sea, or force and direction of wind, it has been our practice simply to record the speed which the reduced power would give if the vessel had a clean bottom and were steaming in smooth water. In the Navy Estimates for 1890–'91, particulars are given for all the ships now building, not merely of the contractor's trial speeds and powers, but the approximate speeds and powers for continuous steaming under the assumed conditions of clean bottoms and smooth waters.

A new regulation, made about three years ago, has given practical tests to this approximate rule for the ratio of power developed when steaming for long periods to the power developed on the contractor's trial. The Admiralty has ordered trials to be made in Her Majesty's ships when newly commissioned, and in some cases after years in commission, extending over ninety-six hours, or such shorter time as might be found more convenient. This is clearly a severe test, especially in the case of newly commissioned ships, but the results have been eminently satisfactory, much more than fulfilling the office assumption. In Table B I give the figures for a considerable number of ships, but prefer not to give the names. Most of these vessels are of quite recent design, but a few are of the older types.

TABLE B.

Duration of trial in hours.	Results of trials (indicated horse-power).		Per centage of actual to contract horse-power.	Remarks.
	Actual.	Contract.		
96	4, 237	5, 000	85	
96	640	900	71	
96	718	850	84. 5	
76	1, 807	2, 300	78. 5	
120	815	950	86	
96	546	600	91	
96	565	600	94	
73. 83	943	1, 000	94	
80	2, 225	2, 200	101	Stopped on account of heavy head sea.
96	2, 195	2, 200	99. 8	
96	980	1, 400	71	
68. 75	4, 855	5, 500	88. 2	
58	843	850	99	
20	735	720	102	Stopped on account of weather.
14	730	720	101	Ditto.
96	754	1, 000	75	
35	545	720	76	
90. 5	1, 995	2, 100	95	Slowed for 5½ hours on account of rough weather.
96	613	1, 400	44	Slowed on account of fog. Net time made up.
96	1, 123	1, 400	80	
90	685	720	95	

An example or two may illustrate what is the effect of the explanations given above. The following are the results of trials and estimates for H. M. S. *Howe*:

Contractors' trials.	Indicated horse-power.	Speed (smooth water, clean bottom).
		Knots.
Forced draft	11,600	16.9
Natural draft	8,200	15.9
Continuous steaming (estimated)	4,500	13.5

Here we have a loss of 3.4 knots per hour from the forced draft trial to estimated working conditions, or of 2.4 knots from the natural draft trial. Any one having only a superficial acquaintance with the matter might speak of the *Howe* as a 17-knot ship; ignoring the fact that "forced draft" is avowedly introduced only for full use over very short periods (three to four hours), when an emergency arises which makes the gaining of a knot or two in speed of supreme importance. But every one familiar with the subject has recognized always the facts to which I now invite attention.

As another example I would refer to the case of H. M. S. *Medusa*:

Progressive trials.	Indicated horse-power.	Speed (smooth water, clean bottom).
		Knots.
Forced draft	10,000	19.9
Natural draft	6,300	18
Continuous steaming (estimated)	3,500	15.75

This class of ship, probably because it is the last completed, has been made the subject of considerable criticism, more especially on the ground that the intended speed has not been realized. As the designer of the vessels I may be permitted to state that the intentions of the design have been realized in all respects; not merely as regards speed, but also draught, trim, stability, and structural strength. The criticism arises from a misunderstanding of facts.

These vessels were designed to have a smooth-water speed of 18 knots per hour with natural draft, when unsheathed with wood and copper; and it was anticipated that the sheathed ships would be about a quarter of a knot slower. The unsheathed *Medusa* on her trials attained 18 knots with natural draft; and the sheathed *Marathon* and *Melpomene* exceeded 17.6 knots with natural draft on their twelve hours' trials.

It was estimated that with forced draft (not exceeding 2 inches of water as air pressure) the unsheathed ships would attain 20 knots as a maximum speed, and the sheathed ships about 19.75 knots. In the first trials of the *Medusa* a speed of 19.5 knots was attained, but the screws then fitted were clearly not suited for these higher speeds. Other screws were fitted; and with fewer revolutions, but the same power, the speed of 19.9 knots was reached. These new screws practically gave no better results than the preceding screws up to 17 or 18 knots, which covered all working speeds; it was therefore decided not to change the screws of the other ships. Without any change of screws the sheathed *Melpomene* made 19.6 knots on her forced draft trial. In view of these facts I think it will be admitted that the intentions of the design have been practically fulfilled.

The contrary opinion rests on a misconception. Prominence having been given to the forced-draft smooth water measured mile trial speed of 20 knots, it has been treated as if it were the sea-speed, but without any official authority. As a matter of fact, before the manœuvres began, a statement was issued to the fleet in which the speed of the *Medea* class for continuous steaming was estimated at from 15.5 to 15.75 knots, and experience justifies this estimate. No doubt this speed could be exceeded for short periods; just as in the chase in the North Sea the *Anson* and *Howe* steamed for six hours, and developed as much power over that period as had been developed on their contractors' natural-draft trials. Further experience with all these new ships will doubtless give better results. It is often overlooked that it is no fair test of what ships can do to take the results obtained on a first commission of the temporary nature incidental to the manœuvres.

The introduction of forced draft has been described by a gallant officer as "an invention of the evil one"—presumably, because it is associated with high temperatures. No doubt forced draft requires careful use, and may be abused. So far as I have been able to ascertain, however, naval officers who have had experience with forced draft are unanimous in desiring to have in their possession the power and control which it gives, although they regard it as a provision for emergencies, and not for every-day use. To be in a position to gain a knot or two in speed each hour for only three or four hours may be of the greatest importance in critical circumstances. To deliberately sacrifice this power while it is retained in foreign war-ships, would be unwise. By circular issued rather more than a year ago, the admiralty laid down special rules for the use of the forced-draft appliances. It has been determined that under ordinary circumstances the air pressure in the stokehold shall not exceed one-half inch of water; and this condition was fulfilled during the manœuvres. It is further ordered that "forced-draft appliances are not to be used above the one-half inch pressure except in circumstances of emergency, and then only for short periods, when the maintenance of the highest possible speed for three or four hours may be of great advantage."

One result of introducing the use of forced draft has been to widen the gap between sea speeds and trial speeds, and hence, as I have explained, misunderstandings have arisen. But I must insist again that the facts have been clearly put before the public in official documents, and that our ships in this matter of recorded speeds are on the same footing as foreign war-ships. For all practical purposes, the natural draft trial speeds are, however, to be preferred to forced-draft speeds, when comparisons are being made, because there may be, and have been, various degrees of "forcing," and the admiralty rule for maximum air-pressure has clearly not been adhered to in the trials of some foreign ships.

Another circumstance deserving notice is that the introduction, in recent years, of swift cruisers of small size has necessarily been accompanied by greater disparity between trial speeds in smooth water and speeds at sea. This is only another way of saying what has already been said—that the larger ship feels the check of the sea upon her speed less than the smaller ship, and may actually be capable of running down the smaller one at sea, although incapable of doing so in smooth water. This source of reduction in sea speeds is necessarily incommensurable.

So is that incidental to foulness of bottom. The fact is generally admitted, but scarcely appreciated as it ought to be, and it is so important that I will venture to give a recent illustration.

The *Medea* was ordered to be tried late in 1888 as a typical vessel of this class. Orders were given that her bottom should be perfectly clean and fresh painted at the time of trial. These orders were not fully carried out, and no anti-fouling composition was applied. The ship was also kept afloat for several weeks in the basin before proceeding on trial. These circumstances did not come to my knowledge until the trials were in progress, when it became obvious that some causes of seriously increased resistance or waste of power were in operation. The trials were stopped and the vessel docked. Her bottom was found to be in a rough and dirty state, fully accounting for the unsatisfactory performance.

The sister ship *Medusa* was then tried under identical conditions of draft and trim, with engines by the same firm, and with screws of the same dimensions; the only difference was that her bottom was clean. In the *Medea* 5,800 horse-power had been required to attain a speed of 19.9 knots; this power sufficed to give the *Medusa* a speed of 17.6 knots, and 5,000 horse-power gave her a speed of 17 knots. At lower speeds the difference was equally marked. For 13 knots the *Medea* with a rough coating, required nearly 2,000 horse-power, as against 1,600 horse-power for the *Medusa*, with a smooth skin. It will be understood that the condition of the *Medea* was not nearly so bad as that of many ships on actual service; and the figures given illustrate the importance of frequent docking and cleaning of the bottom in ships intended for high speed. They also furnish a strong argument in favor of the course taken by the admiralty in giving wood and copper sheathing to a large proportion of the new cruisers now building.

IV. SPECIAL CHARACTERISTICS OF WAR-SHIP PROPULSION.

It is very much the fashion to criticise adversely the steaming powers of war-ships, and to contrast them unfavorably with those of mercantile vessels. This is done without reference to the essential differences between the services that have to be performed by war and merchant ships, or recognition of the inherent difficulties attaching to war-ship propulsion.

Speaking broadly, a merchant ship is built and engined for the purpose of steaming continuously at certain maximum speeds. Passenger steamers are constructed to cover certain distances from port to port, at certain specified speeds. In fact merchant steamers work under fairly uniform conditions of development of power and revolutions of engines, and everything is and can be regulated to give the best results under these conditions. Every one on board is accustomed to fairly regular performance, and this fact greatly favors economy and efficiency, and their regular return to port enables constant attention to be given to desirable repairs or adjustments.

A war-ship is by no means similarly circumstanced. Assuming the simplest case, where she is proceeding alone, it will be found that she is not so favorably placed. Such passages and most of her cruising is done at low speeds, requiring only a small proportion of the power she possesses, in order that on occasion she may rush up to a high speed. This difficulty becomes greater as the upper limit of speed is raised. For example, the *Howe* can be driven at 9 knots for less than 1,200 horse-power, not one-sixth of the power she can develop with natural draft for a few hours. Yet she has to carry about always engines and boilers capable of giving her a speed of over 15 knots with natural draft, and over 16.5 knots with forced draft. The "waste work" inevitable under circumstances of this kind must be considerable at low cruising speeds, although every effort may be made to diminish it by using one of the twin screws or other devices. In the *Blake* and *Blenheim*, with engines of over 13,000 horse-power natural draft, four sets of engines have been adopted, with special disconnecting arrangements, to permit of throwing out the forward sets when cruising at low speeds. In this great range of power, and small development under ordinary conditions, is to be found, doubtless, the cause of not a few of the difficulties which arise with war-ship machinery. Such difficulties would disappear if the engines were continuously worked at high speeds like those of the merchant ships.

When a war-ship forms a unit in a fleet the case is still more difficult. It is a grand spectacle to witness the manœuvres of a large fleet, and to see these huge vessels changing formations while keeping stations accurately. But when one realizes what is involved, particularly in the management of the propelling machinery and steering gear, the spectacle becomes even more interesting. Let me take a hypothetical case, and suppose the fleet ordered to manœuvre at 9 knots. Every commanding officer would be compelled to have command of steam equivalent to a possible margin of speed of 2 to 3 knots in order to insure keeping station. This may seem little, but it involves a good deal. I will take an actual vessel for which the case stands as follows:

Knots.	Horse-power.	Revolutions.
9	1, 000	50
11	1, 800	60
12. 25	3, 000	70

In order to secure the ready command of ten revolutions, therefore, above the average ordered, 80 per cent. more power is needed to be available whenever ordered; and to have command of twenty revolutions, 200 per cent. margin of power is needed. Standing on the bridge, and taking observations continuously as to his relative position, the commanding officer is frequently obliged to vary the speed of the engines, and the engineer officers have to be ready to obey promptly the constant flow of orders from the deck. All this is mere matter of course to naval men, but to professional men it furnishes ample explanation of many otherwise difficult questions concerning the consumption of coal, or wear and tear of machinery in war-ships, as compared with merchant ships.

Take another case. A fleet is proceeding, with cruisers thrown out as scouts some distance ahead, say at the same speed of 9 knots. Let us assume that the *Medusa* is the cruiser. For 9 knots, about 550 horse-power only is needed in her, about one-third of what one of her four boilers would give at natural draft, when fully worked. Probably, under these circumstances, fires will be banked in all the boilers. The admiral signals suddenly to proceed with all dispatch in some direction; let us assume it to be straight ahead. Now, clearly, some time will be necessary to work up from 550 horse-power to 3,500 horse-power, or 4,000 horse-power, and the regulations provide against rapid changes being made in the pressures of steam or temperatures of boilers. For purposes of illustration only let it be assumed that an hour is occupied in so working up to, say, 16 knots speed. Then the mean speed for the hour of the *Medusa* would be about 12.5 knots, and although at the end of the hour she would be steaming 16 knots, she would only have gained 3.5 knots on the fleet.

I commend this short statement to the notice of the gentlemen who, during the recent manœuvres, were so greatly surprised that so-called swift cruisers when ordered to proceed with all dispatch did not immediately rush off at full speed, and speedily disappear in the distance.

It is also very important to note that in a cruiser employed as a scout, with the fires alight, but banked in order to be in a position to rapidly raise steam, there can be no equation of the coal consumed to the power required simply to keep company with the fleet. The fact is obvious enough, but is not unfrequently overlooked.

Still another example. In the chase towards Ushant the *Hero* was steaming about 12 knots, with the *Howe* and *Rodney* attending her, and the *Camperdown* was keeping just outside the range prescribed by the rules. Let us suppose she was 2 knots distant. Suddenly she turns and comes down upon the *Howe* and *Rodney* at a speed of 13 to 14 knots. so that her relative speed of approach would be 25 to 26 knots an hour. In less than five minutes she would be close upon her enemies, and if both kept on they would soon be far apart again. A spectacle of this kind impresses one greatly, and indicates how important a part in future naval actions the auxiliary armaments and quick-firing guns must play, for with all things at their best three minutes are necessary to reload a 67-ton gun.

This paper has extended to a much greater length than I proposed, yet before closing I must allude briefly to one or two other points which have been brought prominently before the public.

There have been allegations, for instance, of structural weakness in some of the ships engaged in the manœuvres. For these allegations there is no foundation whatever in any of the reports received. As an example of the loose way in which these statements are made, I may mention that a short time ago an officer from one dock-yard was sent to another to take notes of certain small fittings in ships of the *Medea* class, in order that similar fittings might be carried out in the *Medea* and *Medusa*. It was immediately announced that he had gone to obtain particulars of structural strengthenings required in consequence of original weakness of construction. This erroneous statement was circulated far and wide; but it had no foundation whatever, as all the vessels of the class have proved to be amply strong, and almost entirely free from vibration even when developing the full forced draft power. It would be idle to attempt to correct or contradict statements of this kind; but before this institution it may not be out of place to allude to them.

There were a few instances, to some of which I have already referred, where miner defects of workmanship caused leakage and discomfort in some of the ships—not the *Medeas*. None of these, however, indicated structural weakness.

Experience in these manœuvres has led to alterations, or rather to additions, in certain classes of ships, which may be grouped under three heads.

(*a*) Additional ventilation has been found desirable, especially to engine and boiler rooms placed under protective decks. So far as past experience could guide, the arrangements originally fitted might reasonably have been expected to prove efficient; but with increasing pressures of steam, greater powers, and multiplied auxiliary machinery, further ventilation was clearly necessary, and is being supplied.

(*b*) Greater facilities for intercommunication between engine-rooms and boilers at a low level in the ships have been proved to be absolutely necessary for safety and good working, and are being provided. Similar experience has, I know, been gained in some high-powered merchant steamers. Of course this involves forming doors in bulkheads, but with the perfect drill in closing water-tight doors now established in the navy the interference with unbroken water-tight subdivision can be accepted.

(*c*) Improved arrangements for the transport of coal from the upper bunkers to the fires in ships, with protective decks, have been shown to be desirable by the hard continuous steaming done during the manœuvres. This matter had been very carefully studied in all recent designs, and it was clearly undesirable to pierce protective decks more than was absolutely necessary. The principle on which I have proceeded in the *Medea* class, and all subsequent designs, is to stow at least half the coal, and often a larger proportion, in bunkers below the protective deck and adjacent to the stokeholds. For the bunkers above, longitudinal transport has been arranged; so that all the coal can be readily carried where required and dropped into lower bunkers near the fires. All these arrangements stand good; the additions consist of three or four additional scuttles on each side placed within the bunkers and fitted with armour covers. I venture to state the facts, as it would appear from some published statements, that instead of the simple addition we had been engaged in some reconstruction of the vessels.

In the belted cruisers similar but more extensive changes are needed to facilitate coal transport; these have been completed already in several of the vessels, and the others are in hand.

One very useful purpose of the manœuvres is to discover any features in the ships, or their equipment, which can be substantially improved; and when, as last year, many new ships of different types are sent to sea for the first time, some such discoveries are inevitable. The foregoing remarks summarize all important suggestions received; besides these there were considerable numbers of recommendations on minor points which will be of service in building the ships now in progress.

In conclusion, let me say that, while the test applied to Her Majesty's ships by their temporary commission for the manœuvres is necessarily a very severe one, and not of a character to show all that can be got out of the ships when officers and men have grown accustomed to their surroundings, it is a matter for congratulation that this great fleet was brought together, sent to sea, and passed successfully through the manœuvres without any accident worth notice. There were, no doubt, derangements of machinery, temporary troubles with boilers, and other incidents, which were not of an important nature. And it speaks well for the professional ability of the officers and men of the navy, that under the circumstances such excellent results were obtained. Had the manœuvres lasted longer, still better performances would have been secured.

VII.

THE MINISTRIES OF MARINE AND PERSONNEL OF SEVERAL EUROPEAN NAVIES.

By Lieut. G. W. MENTZ, U. S. Navy.

Much attention has been given, of late, by foreign governments to the organization of their navy departments. Some have been entirely reorganized and in others important changes have been made. In the following pages the latest available information on the systems of administration in the ministries of marine prevailing in Europe, are given.

In the more autocratic governments it would seem that the belief exists that a naval organization should be governed entirely by naval men, and in Austria, Germany, and Russia, the Emperor exercises his authority in the navy through a commander-in-chief responsible to and appointed by himself from among officers of high rank belonging to the military branch of the navy.

In countries governed by Parliament, naval influence is naturally great in all affairs pertaining to the navy, but it is not paramount.

In Italy and France the navy is represented in the cabinet by a Minister of Marine who is reponsible to Parliament, of which body he is a member. In England the navy is administered by a Board of Commissioners, but no doubt exists as to the full measure of responsibility of the First Lord. He is responsible to Her Majesty and to Parliament for all the business of the Admiralty, and is practically Minister of Marine. He is a member of Parliament.

In England and France, the present heads of the naval establishments are civilians, while in Italy the Chief Constructor of the Navy is Minister of Marine, and is assisted in his duties by a rear-admiral as Under Secretary of State for the Navy.

These civilian chiefs are held entirely responsible for keeping the Navy, over which each governs, up to the strength decided by the policy of the Government, for keeping up its efficiency, for distributing, managing and preparing the fleet for war, so as to get the best possible results. But they can not possibly have all the professional and technical knowledge required for these duties, and the problem has been "how to give them the best professional advice and assistance under the most responsible conditions." Recognizing the "nature of the questions of naval policy which have to be considered and ultimately decided by these ministers, acting on their own responsibility and possessing no previous knowledge or experience in such matters," the duty of advising them on such subjects has been confided to permanent councils, composed of naval officers of high rank, who are free from the routine and detail work of Directions or Bureaus.

In European Ministries of Marine the work of administration is usually divided into three or four grand divisions—Personnel, Material, and Finance (accounts, etc.). Where there is a fourth it is that of Artillery, or of Torpedoes, or of both combined. The chiefs of these grand divisions are selected by the Minister from among naval officers of high rank. A paymaster is generally in charge of the Finance Division. In England the Financial Secretary, a civilian, has these duties. In England, Russia, Germany, and Austria, the Division of Material is in charge of an officer belonging to the military or executive branch of the navy, while in Italy and France a naval constructor is chief of this division. An officer of the executive branch is always in charge of the Personnel Division, and when there exists a separate grand Division of Artillery, or of Torpedoes, it is invariably in charge of an officer from that branch. The grand divisions are divided into sections or offices, each in charge of a technical expert, either a naval officer or a civilian. A detailed statement of the distribution of work in each of the ministries will be found in the description of each.

One feature common to all the European ministries is the separation of the executive from the administrative duties. In England the executive duties are confided to the First Sea Lord and his associates, the Second and the Junior Sea Lords. In France and Italy the Chief of the General Staff, who is also the Director of the Ministers' Cabinet, is charged with these duties. In Austria the Marine Commandant delegates these duties to his private cabinet, the chief of which is a captain. In Russia the Chief of the General Staff is the immediate Commander of the Personnel and is responsible for its efficiency, and also that of the Fleet, and originates all orders for movements of the Fleet in time of peace and war; and in Germany the *Ober-Commando* directs the fleet when it is in commission.

In studying the question of promotion and retirement the fact is forcibly presented that foreign governments recognize that an officer beyond a certain age, for certain duties, ceases to be of the greatest usefulness, and systems are adopted by which officers are advanced to positions of responsibility before the encroachments of age have undermined their abilities. These governments do not rapidly promote their officers from any mere sentiment of reward, but look upon them as weapons of warfare, the most important of all weapons, as possessing the minds to direct the other weapons, and it is their policy to have *them* of the best as much as it is their policy to have their ships and guns and torpedoes of the best.

Promotion in Germany and Austria is not out of turn, but in Germany it is the strictest kind of selection for merit. An officer is constantly under the scrutiny of his seniors in rank, who must periodically report upon his merits, and when it comes his turn for promotion, if the reports are not satisfactory he is dropped from the service. There is no fixed age for retirement, but the reports show when he has passed the age of efficiency. The fact that the average age for promotion to commander is thirty-two, to captain forty-two, and to rear-admiral about fifty, shows with what "rigor and severity" the requirements are carried out. In all the other countries there is promotion by seniority and by selection, and in Italy, in addition to these methods, by competitive examination. There are age limits, time limits, and sea-service limits in each grade as requirements for promotion, and compulsory retirement for age in each grade.

Foreign governments are careful in the classification of the officers of their Navies to designate them in such approved manner as can leave no doubt even to others than themselves, as to the meaning intended to be conveyed by the term used. No government other than our own uses the expression "Line Officer" in connection with Naval officers, that term being confined to the Army, where captains and lieutenants, who are in the line of battle, are called such to distinguish them from Field and Staff Officers whose positions in battle are not in the line. While in some navies there are *grades* of Staff Surgeon, Staff Paymaster, and Staff Engineer, yet such officers, as a class, are designated "Non-Combatant Officers" or "Officers of the Civil Branch," in contradistinction to the "Combatant Officers" of the "Military" or "Executive Branch." By the term Staff Officer is meant not an Engineer, Paymaster, Chaplain, Professor, or Surgeon, but an officer of the General Staff, whose members invariably belong to the Executive Branch, and whose duties are entirely different from those of the officers in our service officially known as Staff Officers. *Professors and *Chaplains have no relative military rank, and their duties being in no sense military they retain in the navies their titles of civil life.

The *titles* of officers in all the navies are very similar to those in our own service except in the engineer branch, and in all the countries, England excepted, the officers called engineers in our Navy have the title of "*officiers mecaniciens*," "*officiali macchinisti*," "*maschinisten*," or "*maschinen-ingenieurs*," the title engineer being confined to the construction branch. How and from what sources these and all other officers are recruited will be found in the description of each class.

In the preparation of the following paper, foreign official documents, laws, and regulations, and United States naval officers' reports have been freely quoted from, the intention being to give only such information as is authentic.

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* Naval Instructors in England and Chaplains in Austria have relative rank.

ENGLAND.

The following extracts are taken from the report (issued in March, 1890) of the last royal commission appointed to inquire into the civil and professional administration of the naval and military departments, and the relation of those departments to each other and to the Treasury:

THE INTERNAL ADMINISTRATION OF THE ADMIRALTY.

Your Majesty's navy is administered by a Board of Commissioners appointed by patent to execute the office of "High Admiral." Under the patent full power and authority are conferred upon "any two or more" of the commissioners to do anything which belongs to the office of our High Admiral.

In accordance with the terms of the Order in Council of the 19th of March, 1872, the administrative business of the Admiralty is now distributed among the Lords and the Parliamentary Secretary by the First Lord acting on his sole discretion. A redistribution of business was made in December, 1888, under which important additions were made to the duties for which the First and Second Naval Lords are respectively responsible.

As at present constituted the Board of Admiralty comprises the First Lord, four Naval Lords (of whom one is also Controller of the Navy), one Civil Lord, the Parliamentary and Financial Secretary, and the Permanent Secretary. The Admiralty establishment is divided into departments, for the superintendence of one or more of which each Naval Lord, the Civil Lord, and the Parliamentary Secretary are severally responsible. The Permanent Secretary is responsible for the correspondence of the office, for the discipline of the civil establishments in London, and for maintaining a general continuity of administration on the advent of a new Board.

The effect of this system, as a working machine, appears to be that the administration of the navy devolves upon the Lords charged with the superintendence of departments, who direct the general business of the service on their individual responsibility, but refer questions of special importance for the decision of the First Lord. At the same time, the frequent meetings of the Board insure full discussion of such questions as the First Lord desires to refer to it, and thus supplement the advisory powers of individual lords.

Thus, in fact, the Admiralty is not administered in accordance with the terms of the patent, under which equality of responsibility appears to be conferred upon the members of the Board, but in accordance with long usage confirmed by recent orders in council. This involves a certain anomaly. The actual system of administration does not rest upon a Board of Admiralty, but upon the supreme authority of the First Lord, whose power in the distribution of business among the Lords is absolute within the limits defined by the before-mentioned orders in council. In this distribution differences of administrative and executive powers must necessarily arise. Thus, the First Sea Lord has long been recognized under the schedule of his duties as the principal adviser of the First Lord, and has occupied on that account a special position.

The anomaly above pointed out probably lies at the root of much of the criticism which has been expended upon the administration of the Admiralty, and it might, therefore, seem desirable to effect reconciliation between the terms of the patent and present usage. The difficulties which would arise in attempting to carry out the necessary changes would, however, be considerable, and we doubt whether sufficient advantage would be gained thereby.

The evidence proves that, within the Admiralty itself, except upon one important point to which we shall hereafter refer, no doubt is felt as to the measure of the relative responsibility of the First Lord and of the Naval Lords. As regards ordinary matters of administration, the responsibility of the First Lord for the whole administration of the navy is clearly laid down by the order in council, and the Naval Lords are responsible to the First Lord for the transaction of such business as he may allocate to them severally. If, therefore, there is any want of definite administrative responsibility of the Naval Lords to the First Lord it must arise from a want of the necessary precision in the definition of the duties and functions assigned to each member of the Board.

As regards the consultative functions of the Board there is, however, some difference of opinion. Sir Arthur Hood, in his evidence before the select committee of the House of Commons in 1888, stated that while the First Lord is responsible for the whole of the navy, the members of the Board are all equally responsible with the First Lord for the strength and sufficiency of the fleet. And, before the same committee, Rear-Admiral Hotham stated that the responsibility for a decision taken by the Board is shared by any Naval Lord who does not protest, or, if the matter is of great importance, resign; further, that in the case of so great a question as the sufficiency of the navy, it must be considered, so long as the Naval Lords continue to hold office, that the majority of the Board are satisfied that the defensive requirements of the country are satisfactorily met.

These consultative duties are now, in the table of distribution of business recently issued, clearly allotted to the First Naval Lord, which was not the case previously, and we should have been disposed to consider that, with the direct supervision of the Intelligence Branch, which is so closely connected with them, they would have been fully sufficient to occupy the whole time of this officer, who is now *de facto* Chief of the Staff to the First Lord. But it is the opinion of all the officers and authorities who have given evidence before us that these consultative functions could not with advantage be separated from some, at least, of the administrative duties which now devolve upon him, which keep him in constant communication with the officers of the navy, and secure that he is fully informed of the opinions, requirements, and condition of the service. We are not prepared, on the the information before us, to deny the accuracy of this assertion, but we doubt whether sufficient consideration has been given to the immense importance of the consultative duties of the principal adviser of the Minister, and we are convinced that, at the least, every effort should be made to relieve this officer of all the duties of detail which can be equally well performed by one of his colleagues, and which are not absolutely essential to the maintenance of that touch with the service which his present duties are asserted to secure.

Our recommendations as to the administration of the Admiralty may be summed up as follows:

(1) Full recognition of the complete and individual responsibility to Parliament and the country of the cabinet minister at the head of that department for all matters connected with Your Majesty's navy.

(2) Constitution of the office of the First Naval Lord as that of chief adviser of the First Lord in all great questions of naval policy.

(3) Clear definition of the administrative duties of each of the remaining Lords, and direct responsibility of each of them to the First Lord for his own duties.

(4) The Board to be regarded as a standing council for naval affairs, but the existence of such council in no way to diminish the responsibility of the First Lord.

A summary of the evidence of the various members of the Board of Admiralty is as follows:

The First Lord is responsible to Her Majesty and to Parliament for all the business of the Admiralty, the business to be transacted in three principal divisions.

The First Naval Lord, the Second Naval Lord, and the Junior Naval Lord are responsible to the First Lord of the Admiralty for the administration of so much of the business relating to the personnel of the navy and to the movement and condition of Her Majesty's fleet as shall be assigned to them from time to time by the First Lord. The Controller is responsible to the First Lord for the administration of so much of the business as relates to the *matériel* of the navy. The Financial Secretary is responsible to the First Lord for the finance of the department and for so much of the other business of the Admiralty as may be assigned to him.

The Civil Lord and Permanent Secretary to have such duties as shall be assigned to them by the First Lord. For each and all of the duties assigned to the respective Lords they are held personally responsible to the First Lord.

PROCEEDINGS OF THE BOARD.

Meetings once a week and the matters brought forward for formal approval and stamp are: navy estimates; designs for new ships and alteration in weight of; alterations in general regulations; dismissals or discharges of naval officers; restoration and refusal of restoration; decision as to non-employment; alteration in dates of birth; orders in council; general orders, circulars and other important orders of a legislative character; such other consultative business as may be determined by the First Lord. No paper is brought before the Board except with the First Lord's approval. Ship-building boards are specially called together by the First Lord; and the Controller and Director of Naval Construction, the Director of Naval Ordnance, and the Engineer in Chief attend as required. The decision, arrived at at Board meetings, as well as the more important minutes of their Lordships, are printed daily in a compact form which is sent to the members of the Board and the heads of departments and the papers themselves are marked after the execution of the minutes, to any other department which may be affected by the decision given. Correspondence received at the Admiralty is at once registered, and matters of interest are entered on the schedule, which is sent every morning to each member of the Board who can specially ask for any paper he may desire to see out of the regular course.

All letters written actually in the name of the Board are signed by the Secretary, except certain letters to the treasury, which are referred to the Accountant-General, then to the Financial Secretary for signature. In important cases the First Lord's approval is obtained before the letter is signed.

The Board means two Lords and the Secretary or possibly one Lord only. Orders given in the name of the Board may emanate from any one or more Lords. Correspondence is carried on in the name of the Board though it may be on the initiative of only one Lord.

DISTRIBUTION OF BUSINESS, 1890.

FIRST LORD.

1. General direction and supervision of all business relating to the navy.
2. Political questions.
3. Board questions.
4. Promotions and removals for the service of naval and marine officers.
5. Honors and rewards.
6. Royal yachts, including appointment of all officers.
7. Civil appointments and promotions, except as provided under Comptroller of the Navy, and Civil Lord.
8. Mersey conservancy.
9. Nominations to naval cadetships and to assistant clerkships, R. N.
10. Appointments of—
    - Flag officers.
    - Captains.
    - Officers commanding ships.
    - Commanders to Coast Guard.
    - Chaplain } Temporarily delegated to junior naval lord.
    - Naval instructors. } Temporarily delegated to junior naval lord.
    - Inspectors and deputy inspectors of hospitals and medical officers holding civil appointments.

11. Staff appointments of the royal marines.
12. Grants in aid of churches and schools.

FIRST NAVAL LORD.

1. Ships in commission.
2. Distribution and organization of the fleet.
3. Marines and marine artillery.
4. Appointments of commanders under captains.
5. Complements of ships.
6. Discipline.
7. Court-martial and courts of inquiry.
8. Punishment returns.
9. Protection of trade and fisheries.
10. Hydrographical department and pilotage.
11. Signals.
12. Collisions.
13. Slave trade.
14. Gunnery and torpedoes, as relate to personnel and ships in commission.
15. Prize questions.
16. Deserters, reward for apprehension of; removals of R.
17. Leave to officers and men in ships in commission.
18. Intelligence department, superintendence of,* and mobilization of fleet.
19. Naval attachés, movements of, and orders to.
20. Uniform regulations.
21. Maritime defense and strategical questions—to advise.

SECOND NAVAL LORD.

1. Manning of the fleet.
2. Steam reserves—as regards officers and men.
3. Training establishments.†
4. Naval colleges.
5. Coast Guard, except buildings.
6. Royal naval reserve.
7. Royal naval artillery volunteers.
8. Pensioners—when called out. Mobilization of reserves.
9. Interpreters.
10. Medals.
11. Mobilization of fleet as far as relates to personnel.
12. Education of officers, men, and boys of the royal navy; royal marine schools—except civil appointments.
13. Appointments of—
    - Lieutenants, except to commands.
    - Sub-lieutenants.
    - Midshipmen and naval cadets.
    - Navigating officers—except to commands.
    - Gunners.
    - Boatswains.
    - Engineer officers.
14. Chief and engine-room artificers.

THIRD NAVAL LORD AND CONTROLLER OF THE NAVY.

1. Dockyards.
2. Steam reserves—as regards material.

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* Intelligence department, general superintendence of, since January, 1887.

†Including engineer sudents since 1887.

3. Construction and repair of ships and machinery.
4. Purchase and disposal of ships.
5. Loan of ships, tugs, etc.
6. Inventions—relating to ships, machinery, ordnance, and torpedo material, etc.
7. Models at Greenwich.
8. Dockyard craft, personnel, and material.
9. Dockyard Police.
10. Dockyard and victualing yard machinery and caissons.
11. Electric lights.
12. Naval Ordnance Department material and stores—(including torpedoes.)
13. Armed cruisers—engagement of.
14. Naval Store Department at the Admiralty and dockyards, including coals for dockyards and factories, and stores for the fleet.
15. Moorings.
16. Royal corps of naval constructors.
17. Dockyard foremen, inspectors, and subordinate officers and workmen—promotions, transfers, and leave.

JUNIOR NAVAL LORD.

1. Transport service.
2. Medical service.
3. Victualing service.
4. Hospitals and hospital ships.
5. Coaling the fleet.
6. Passages.
7. Appointments of—
    - Medical officers, except as otherwise provided for.
    - Paymasters.
    - Assistant paymasters, clerks, and assistant clerks.
    - Carpenters.
    - Chaplains and Naval Instructors (temporarily delegated).
8. Pensions to seamen and marines.
9. Pensions to widows of naval and marine officers.
10. Full and half pay.
11. Table money.
12. Compensation and allowances—as regard the fleet.
13. Debts of officers and men.
14. Ships' libraries.
15. Prize money and bounty for pirates.
16. Deserter's effects.
17. General salvage questions, and salvage of naval stores.
18. Naval savings banks.
19. Freight of treasure.

CIVIL LORD.

1. Works Department, including contracts and purchases of stores and land; also Coast Guard buildings, sites, and leases.
2. Naval Establishments—civil staff, including classification, appointment, promotion, pay, allowances and pension (except appointments and promotions in London establishment, and of professional officers of Controller's Department at the dockyards).
3. Greenwich hospital business.
4. Subscriptions, etc.
5. Compassionate allowances, etc.

6. Charitable fund.
7. Allowances to ministers of religion.
8. Department of Inspector of Naval Schools, including dockyard schools and civilian schoolmasters and schoolmistresses.
9. Special questions affecting retirement, pay, and allowances of naval and marine officers and men.

PARLIAMENTARY AND FINANCIAL SECRETARY.

1. Finance.
2. Estimates.
3. Expenditure generally.
4. Accounts. Cash, store, and dock-yard expense.
5. Purchases and sales of stores generally.
6. All proposals for new and unusual expenditure.
7. All questions involving reference to the treasury financially.
8. Exchequer and audit department—questions connected with.

PERMANENT SECRETARY.

1. Discipline of the various departments of the Admiralty, and recommendations for appointments and promotions in the Admiralty office.
2. Correspondence.
3. Appointment of messengers.
4. Foreign naval attachés—communications with.
5. Lock wards in hospitals receiving assistance from Admiralty.

Note.—Routine papers, as defined below, will be disposed of by the permanent secretary:

(*a*) Such as require intermediate action or reference to render them sufficiently complete for decision by the Board.

(*b*) Such as do not involve some new principle, establish a precedent, or occasion expense not provided for under existing regulations.

(*c*) Such as do not involve any point of discipline, or affect the movements of or orders to a ship.

The permanent secretary may be a naval officer or civilian. Is the official mouthpiece of the Board of Admiralty and is charged with the responsibility of carrying into effect whatever orders they may decide to issue.

He sees the correspondence that comes into the office, the telegrams, and the reports prepared by the various branches.

He checks the marking of papers and finally signs the outgoing correspondence.

He is in constant communication, chiefly personal, with the various Lords, and is therefore enabled to acquire a general knowledge of the business of the Admiralty, and to prevent the various departments from acting independently.

He has the exclusive charge of the Secretariat, or the Central Department, and the discipline of all the London Admiralty departments.

He also keeps the thread of administration unbroken on the constitution of a new board or on a change of government.

DUTIES OF HEADS OF DEPARTMENTS.

CONTROLLER.

Is a member of the Board of Admiralty and is responsible to the First Lord for the administration of so much of the business as relates to the *matériel* of the navy; that is, to the building and repairing of ships, to guns, and to naval stores, and for this purpose has under him:

The Director of Naval Construction and Assistant Controller;

The Director of Naval Ordnance;
The Engineer-in-Chief;
The Director of Dock-yards;
The Director of Stores.

The dock-yard expense accounts are under charge of an inspector, and the secretary of the Controller has charge of the clerical staff.

The Director of Naval Construction and Assistant Controller.

Is responsible to the Controller for all matters of design and construction in hulls of ships and boats, including masting, torpedo and electric-light apparatus, whether building in the dock-yards or by contract, and is also responsible for the survey of merchant-ships, as to their suitability for engagement as armed cruisers, keeping a list thereof. He is also to visit and survey the various ships in progress at the dock-yards and elsewhere as may be necessary, to see that the designs are being carried out in all their details to his satisfaction.

The Engineer-in-Chief.

Is responsible to the controller for all matters of design and construction of steam machinery in ships and boats, and is jointly responsible with the Director of Naval Construction and Assistant Controller and the Director of Naval Ordnance for the design and manufacture of gun-mountings, and for mechanical arrangements connected with the supply and fitting of torpedo apparatus, and electric lighting of ships or boats. He also submits to the Second Naval Lord questions relating to the engineer training establishments, and advises on matters concerning the engineers of the royal navy, submitting to the Junior Lord the appointment of all engineer officers.

The Director of Dock-yards.

Is responsible to the Controller for the building of ships, boats, etc., in the dock-yards, and for the maintenance and repairs of ships and boats, and of all steam machinery in ships, boats, dock-yards, and factories, and is responsible in matters relating to the management of the dock-yards, so far as it affects the number, appropriation, and pay of the men, the economical performance of work, and the introduction and use of machinery in the dock-yards and factories. He is to consult the Engineer-in-Chief in matters connected with machinery. He is to constantly visit the dock-yards.

The Director of Naval Ordnance.

Is to advise the First Naval Lord on all questions connected with the gunnery and torpedo-training establishments of the navy. He is responsible to the Controller of the Navy for all questions connected with the ordnance and torpedo material of the navy, whether relating directly or indirectly with the design, construction, repairing, or fitting of ships, their guns, gun and torpedo mountings, magazines, shell-rooms, torpedo and electric fittings connected with the armament, including the arrangements necessary for their efficient working and maintenance.

It is his duty to suggest to the Controller of the Navy any change of armament of ships which he considers desirable; and all proposals for the armament of new ships, or for alterations of armament are to be referred to him for his opinion and suggestions. He is placed in immediate and personal communication with the Director of Artillery and Stores at the War office, and he will endeavor to facilitate decisions on all matters of detail conected with war-like material supplied to the navy by the War department. All the drawings and specifications connected with ordnance and torpedo mountings are to be signed by him and the Director of Naval Construction. He is to prepare and submit the estimates for ordnance and torpedo material. He is assisted on all torpedo matters by the Assistant Director of Torpedoes, who sees that all ships are provided with the torpedoes, torpedo carriages and fittings, torpedo and electrical stores, and electric search-light apparatus which are approved for them; advises in regard to torpedo armaments of ships and boats; as to the establishment of the necessary depots for torpedo and electrical stores at home and abroad, and sees that they are properly provided with approved reserves of stores; also that all torpedoes, etc., are kept in repair and ready for immediate use. He also visits, as may be considered necessary, the various torpedo depots and manufactories, attending trials and experiments when requisite.

PROCEDURE TO BE OBSERVED WITH REGARD TO THE PREPARATION OF DESIGNS OF HER MAJESTY'S SHIPS.

1. Cases having recently been brought to the notice of my lords, in which the immersion of a ship when complete for sea will be seriously and prejudicially affected by reason of introduction during construction of additions and alterations to the hull, machinery, complement, armament, etc., the procedure hereafter defined is to be strictly observed.

2. When a design for a ship is required the Controller will furnish the Board with a general idea of the class of vessel required.

3. The Controller will, after conferring with the First Naval Lord, and obtaining his written approval as to the speed, armament, complement, and sail power, if any, instruct the Director of Naval Construction to prepare a sketch design for consideration embodying such features as may have been decided upon by the First Naval Lord and the Controller.

4. The Director of Naval Construction, after conferring with and obtaining the opinion in writing of the Director of Naval Ordnance and the Engineer-in-Chief as to the armament and machinery respectively, is to prepare a sketch which shall be submitted to the Controller, who will bring the same before the Board.

5. If the sketch design is generally approved by the Board, orders will be given by the Controller that the design is to be worked out in detail, or modified with a view to its ultimate adoption (the sketch design will be prepared in accordance with the Board minute of 21st September, 1886, relating to load draught).

6. The Director of Naval Construction will, in consultation with the Director of Naval Ordnance and the Engineer-in-Chief, complete the design, and submit it, with a full and careful description of the expected qualities and capabilities of the ship for the concurrence of the Controller, by whom it will be sent to the Secretary for circulation to the several members of the Board, before being considered at a Board meeting.

After a design has been approved by the Board, and has received the Board stamp, not any alteration or addition either in hull, machinery, armament, complement of men, boats, or stores, or other detail shall be permitted without the concurrence of the Board.

7. The Controller shall be responsible that not any deviation from the design approved by the Board shall take place which would in any way affect the immersion of the ship when completed for service. (Board Minute, 15th February, 1887.)

[First Lord's minute of 5th December, 1887.]

8. After the design of a vessel has been discussed and finally approved by the Board, any question relating to the seaworthiness of such a vessel should be raised by itself and addressed to the First Lord, and not in connection with consideration of designs of other vessels. (Admiralty, 15th February, 1887.)

The Director of Stores.

Is responsible under the Controller for maintenance of a sufficient stock of naval stores, coals, etc., for the service afloat and ashore. Watches expenditure thereof. Prepares estimates for naval stores and regulates expenditure of money voted. Has authority to approve the purchase of stores up to £100, without higher approval. Examines and passes all accounts rendered in connection with naval stores. Is to visit yards and inspect store-keeping arrangements, but may not act in any matter of importance without superior authority.

The Inspector of Dock-yard Expense Accounts.

Is to keep a constant and close record of all expenditure at the dock-yards. To supervise the expense accounts, and see that they are properly and promptly prepared, and that they are clear and trustworthy, so that the progress of expenditure, in comparison with the estimates, or authority for expenditure, may be closely watched by the Controller of the Navy. To review and report upon expenditure for which the Controller is responsible, especially with regard to such as can not be debited to the cost of ships and manufactures. He is frequently to visit the yards in connection with the duties.

The Accountant-General.

Has no printed instructions beyond the Order in Council of 18th November, 1885, and office memorandum of 10th December, 1885, but is responsible for preparation of the navy estimates, posting the Admiralty ledgers and subsidiary books, and making out the appropriation account, involving appearance before the committee of the House of Commons to answer the criticisms thereon of the Comptroller and Auditor-General.

Financial criticism and check on current expenditure and liabilities, and advising the Board on matters affecting the naval finance generally.

Seeing that the regulations of the treasury and parliamentary decisions are duly carried out on all questions of finance.

Examination and payment, or issue of orders directing payment, of all claims against naval funds involving inquiry for proof of service or supply, rate of charge, conformity with agreement, terms of service or regulation.

Examination of the cash accounts of local accountants and paymasters afloat and ashore.

Regulation of naval and marine full and half pay and retired pay, prize money, savings' bank, allotments, and naval and marine pensions involving calculation of time served, and checking awards of pension.

Record of services of all civil salaried officers, and advising on questions affecting their salaries and retirement.

The Director of Victualing.

Is responsible under the Board for the proper supply, care, and preservation of all victualing stores and clothing required for the fleet. He is also charged with the management of the victualing yards and depots, including the appointments, pay, and promotion of day-pay persons employed therein. He is also to prepare the estimates for the above services (Vote 2), with the exception of certain items, and to regulate the expenditure of the money voted.

Examines and passes all accounts rendered in connection with victualing and clothing stores.

He is authorized to visit the several victualing yards from time to time.

Is not furnished with printed instructions.

The Director of Navy Contracts.

Is responsible for the purchase (on duly authorized requisitions) of all stores, supplies, and machinery required for the use of Her Majesty's naval and marine forces and establishments, and for the conclusion of all contracts in connection herewith, *excluding* only contracts for ships and propelling machinery, and certain requirements of the director of works.

He also sells old ships and old stores of every kind.

He is to confer with head of department concerned as to persons to be invited to tender for machinery and special articles.

He may purchase stores up to £100 in value without superior authority.

He is authorized to visit the several establishments in connection with his duties, also the various manufacturing districts and sources of supply.

The Director of Transports.

Advises the Board as to appropriation of troop-ships and signs charter-parties on behalf of the admiralty.

Is responsible under the board for providing conveyance for troops and seamen, army and navy stores and provisions, and for all persons of the army and navy departments proceeding on government service. He prepares the estimates for these services, and examines all claims on account of transport service before payment.

Keeps the list of vessels to be hired as auxiliaries to the fleet for other service than as armed cruisers, and is responsible for the survey thereof.

Is also charged with the control of the executive and financial duties connected with the conveyance of troops to and from India on behalf of the Secretary of State for India, and he keeps and renders accounts of all receipts and expenditure connected with it.

Is responsible for maintaining a proper and sufficient stock of transport stores and provisions, mess traps and cabin furniture, for troop ships, and for regulating their issue and disposal.

Is not furnished with printed instructions.

Medical Director-General.

Is responsible under the Board for the administration of the naval medical service afloat and ashore, and is the adviser of the Board on all questions connected with the appointment and promotion of Medical officers, and of the Nursing Sisters and Sick-Berth Staff.

He is charged with the superintendence of all professional and administrative details in regard to the medical establishments; and is responsible for maintaining the necessary stores of articles required for the naval medical service.

He has to prepare the estimates and watch the expenditure for the medical service as far as wages and stores are concerned, and is responsible for the examination of the medical store accounts.

He has, also, to prepare for publication the medical statistics of the health of the navy.

Is not furnished with printed instructions.

Director of Works.

Has the general charge of the naval works and property at all Admiralty establishments at home (except in London) and abroad. Is the adviser of the Board on all questions relative to the purchase and disposal of property, the execution of new works and the alteration and repair of existing buildings, and is responsible for the proper design and execution of any works which may be decided upon, and for the purchase of the necessary materials. He prepares the estimates and watches the expenditure for the work to be carried out by his Department (Vote 10,) except as regards the salaries and allowances of the officers superintending works in progress which are furnished by the Accountant-General, and the vote as a whole is referred for the concurrence of the Controller of the Navy.

Is not furnished with printed instructions.

Admiral Superintendent of Naval Reserves.

To command the Coast Guard and to exercise a general supervision and control over the Reserves, viz:

The Coast Guard, ashore and afloat.
The Royal Naval Reserve.
The Royal Naval Artillery Volunteers.

He is in command of the squadron of ships of first reserve.

He also, in co-operation with the customs and the board of trade, takes care that the Coast Guard is vigilant in the protection of the revenue, and in saving and guarding life and property; and, also, that the North Sea and Coast fisheries are duly watched and protected.

Deputy Adjutant-General, R. M.

Exercises under the Board the command, in all matters, of royal marines on shore, the recruiting service included.

He supervises and inspects the several divisions, and watches the interests of officers and men, submitting and applying when necessary such changes as would follow on any revised army regulations.

Is not furnished with printed instructions.

The Hydrographer.

Submits to the Board what surveys in the interests of navigation are most necessary; is responsible for the accurate execution thereof, and deals with all questions arising thereon. He also watches the progress of surveys by foreign nations.

Briefly speaking he may be said to be the scientific adviser of the Board, particularly in regard to scientific expeditions, etc. He is generally the medium of communication between the Board and various public and scientific societies on subjects with which the Admiralty are more or less necessarily and closely interested.

He is also the adviser of the Board on all questions connected with practical navigation, pilotage, grounding of Her Majesty's ships, and on a variety of subjects of a professional or technical character.

He is responsible for obtaining and publishing information respecting navigation, and for construction and publication of charts and nautical directions, also tide-tables and light lists for all parts of the world. He looks after the supply of charts, chronometers, etc., to ships, and is responsible for all matters connected with compasses of Her Majesty's ships, including fitting, etc.

He also advises in connection with conservancy of royal harbors and pilotage, appointment, etc., of surveying officers, and controls scientific vote.

He advises on all questions connected with the Royal Observatories at Greenwich and the Cape of Good Hope, and the Nautical Almanac.

He is not furnished with printed instructions.

Director of Naval Intelligence.

The essence of his duties is "preparation for war," which necessarily comprises the collection, sifting, and recording of all information relating to maritime matters likely to be of use in war, and the preparation and correction to date of a complete plan for mobilizing the naval forces of the Empire.

Also when directed he is to prepare plans of naval campaign for the consideration of the Board, and is to bring to the notice of the Board all points affecting "preparation for war."

The Director of Greenwich Hospital.

Deals with all matters relating to the administration of Greenwich Hospital estates, revenues, and school, submitting for superior authority when necessary, and supervises the economical expenditure of Greenwich Hospital moneys.

Deals with applications for pensions or gratuities to the widows and children of seamen and marines out of Greenwich Hospital funds.

Is charged with collection of the revenue of the Hospital from all sources.

Has authority to approve demands up to £100.

INSTRUCTIONS TO HEADS OF DEPARTMENTS.

The Construction, Engineering, and Dock-yard Branches of the Controller of the Navy's Department (dated 28th May, 1886).

(*a*) *Construction and Engineering Branch.*

The Director of Naval Construction and Assistant Controller.

1. Will be responsible to the Controller for all matters of design and construction in the hulls of ships and boats, including masting, torpedo and electric light apparatus, and all nautical apparatus, whether building in the dock-yards or by contract; also for gun mountings and torpedo mountings to the extent that all questions relating to their introduction, changes of pattern, alteration, etc., will be referred to him by the Director of Naval Ordnance for his concurrence, before they are sent to the Controller. All drawings and specifications connected with ordnance and torpedo mountings are to be signed by him and the Director of Naval Ordnance.

2. He and any of the members of his staff will visit and survey the various ships in progress at the dock-yards and elsewhere, as he may consider necessary, to enable him to satisfy himself that the designs are being carried out in all their details to his satisfaction.

3. No alteration is to be made in any ship under repair without his concurrence.

4. He will also be responsible for the survey of merchant ships, with relation to their use as auxiliaries to the fleet, and for keeping the records of the *matêriel* of foreign navies.

5. The experimental works at Haslar will be under his direction.

The Engineer-in-Chief.

6. Will be responsible to the Controller for all matters of design and construction of steam machinery in ships and boats.

7. He will give such professional assistance and advice as may be requested by the Director of Dock-yards on all matters relating to the extension, improvements, and maintenance of the machinery in dock-yards and factories, as well as those relating to the repairs or alterations to machinery in ships and boats.

8. He will be only jointly responsible with the Director of Naval Construction and Assistant Controller, and the Director of Naval Ordnance, for the design and manufactures of gun mountings, and for the mechanical arrangements connected with the supply and fitting of torpedo apparatus, and electric lighting of ships or boats.

9. For the above-mentioned duties the Director of Naval Construction and Assistant controller will be assisted by two Chief Constructors (assistants to the director of naval construction). Two Constructors. Six Assistant Constructors, first class. Six Assistant Constructors, second class. (*See* note at end of *c.*)

The Engineer-in-Chief will be assisted by—one Inspector of Machinery. Three Engineer inspectors. Two Chief Engineers, or Engineers, R. N. (for special duties.) Two Assistant Engineers, first class. Three Assistant Engineers, second class.

(*b*) *Dock-yard branch.*

1. The Dock-Yard Branch of the Controller's Department will deal with all matters that relate to the general management of the dock-yards, and to the economical performance of work therein.

2. The Director of Dock-yards will be responsible to the Controller of the Navy for the building of ships, boats, etc., in the dock-yards, and for the maintenance and repair of ships and boats, and of all steam machinery in ships, boats, dock-yards, and factories.

3. He will observe and report on the qualifications of the professional officers, and will be responsible in matters relating to the management of the dock-yards, including the number, appropriation, and pay of the men, the economical performance of work, and the introduction and use of machinery in the dock-yards and factories.

4. He will be left such discretion and freedom of action as will make him personally responsible if the work of the dock-yards be not properly and economically executed.

5. He will visit the dock-yards frequently for the purpose of conferring personally with the superintendents, their civil assistants, and the officers of the dock-yards, in regard to the ships and works in progress.

6. In matters connected with machinery he will consult the Engineer-in-Chief.

7. For the above-mentioned duties the Director of Dock-yards will be assisted by one Chief Constructor (Assistant to Director of Dock-yards), one Engineer Assistant, one Constructor, and two Assistant Constructors, first class, for examination of dock-yard works; two Assistant Engineers for examination of engine work.

(c) *Arrangement of duties in absence of heads.*

1. With the exception of letters signed by the Secretary to the Admiralty, the Controller will decide, according to his directions, what letters shall be signed by himself.

2. Other letters will be signed by the Director of Naval Construction and Assistant Controllor, the Director of Dock-yards, or the Engineer-in-Chief.

3. In the absence of the Controller, the Director of Naval Construction and Assistant Controller will act for him on all matters, excepting those relating to ordnance and torpedo *matériel,* for which the Director of Naval Ordnance acts in the absence of the Controller under the instructions of 13th December, 1883.

4. In the absence of the Controller and the Director of Naval Construction and Assistant Controller, the Director of Dock-yards, as junior to the Director of Naval Construction and Assistant Controller, will act for Controller, and in absence of all three officers, the Engineer-in-Chief will act for Controller.

5. In the absence of the Director of Naval Construction and Assistant Controller, the senior Chief Construction Assistant to the Director of Naval Construction will act for him.

6. In the absence of the Director of Dock-yards the Chief Constructor Assistant will act for him in all matters relating to the constructive department of the dock-yards, and the Engineer Assistant in all matters relating to the engineer department.

7. In the absence of the Engineer-in-Chief the Inspector of Machinery will act for him.

8. These instructions are to supersede those contained in the official memorandum, dated the 16th December, 1872, and all instructions subsequently issued for the guidance of the constructive and engineering departments.

(d) *Director of Naval Ordnance* (*dated* 13*th December*, 1883).

1. The Director of Naval Ordnance will advise the First Naval Lord on all questions connected with the gunnery and torpedo training establishments of the navy.

2. He will advise the Controller of the Navy on all questions connected with the ordnance and torpedo *material* of the navy, whether relating directly or indirectly to the design, construction, repairing, or fitting of ships, their guns, gun and torpedo mountings, magazines, shell-rooms, torpedo and electric fittings, connected with the armament, including the arrangements necessary for their efficient working and maintenance.

3. It will be his duty to suggest to the Controller of the Navy any change of armament in ships which he considers desirable; and no proposals for the armament of new ships, or for alterations of armaments, will be referred to him for his opinions and suggestions.

4. He will refer questions relating to ordnance and torpedo mountings, their introduction, change of pattern, alteration, etc., to the Director of Naval Construction for his concurrence before they are sent to the Controller.

5. All drawings and specifications connected with ordnance and torpedo mountings are to be signed by him and the Director of Naval Construction.

6. All approved drawings will be registered in the drawing office.

7. He will be placed in immediate and personal communication with the Director of Artillery and Stores at the war office, and he will thus endeavor to facilitate decisions on all matters of detail connected with war-like material supplied to the navy by the War Department.

8. He will use his discretion in referring to the Controller any changes in the details of fitting of guns or of gunnery material which may arise departmentally with the Director of Artillery, before their final approval for the service is decided upon.

9. Decisions on general and important questions respecting naval ordnance, torpedoes, ordnance stores, etc., affecting the War Department will, as heretofore, be notified officially in the usual way by the Secretary of the Admiralty to the Under Secretary of State for War, and *vice versa.*

10. He will be at liberty to communicate directly with the captains of the gunnery ships and torpedo schools on all ordnance and torpedo subjects.

11. He will prepare and submit for your Lordships' approval, in sufficient time, the estimates for ordnance and torpedo material for the ensuing financial year.

12. He will be *ex officio* a member of the Defence Commissions, and also of the Council of Ordnance.

13. Such naval executive assistance as my Lords may from time to time determine will be allowed him, and a staff of clerks of the Controller's department will be specially allotted for the performance of the clerical work connected with his duties; these clerks will be under the control and direction of the Director of Naval Ordnance, in the same manner as the clerks of the Store Branch are under the Director of Stores.

14. In the absence of the Controller, the Director of Naval Ordnance will act for him in respect of all matters relating to ordnance and torpedo material.

15. He will obtain the sanction of the First Sea Lord and of the Controller whenever he desires to be absent either on leave or on duty.

16. The Assistant to the Director of Naval Ordnance will act for the Director of Naval Ordance in his absence.

(*e*) *Assistant Director of Torpedoes* (*dated* 10*th March,* 1887).

1. To advise and assist the Director of Naval Ordnance on all torpedo matters.

2. To see that all ships are provided with the torpedoes, torpedo carriages, and fittings, torpedo and electrical stores, electric search-light apparatus which are approved for them.

3. To see that the orders contained in Admiralty circular letter, of 4th July, 1884, in regard to torpedo and electrical fittings, and any approved modification of the same which may be made from time to time are strictly carried out. See also instructions for professional officers of dock-yards, articles 58 to 68.

4. To advise as to the establishment of the necessary depots for torpedo and electrical stores at home and abroad, and to see that such as are established are properly provided with the approved reserves of stores.

5. To advise the director of naval ordnance as to all experimental and instructional work carried out by the torpedo school ships *Vernon* and *Defiance.*

6. To watch the progress of the expenditure in the manufacture of torpedoes and torpedo material by Woolwich or private firms, especially as regards time of completion, and to draw the attention of the Director of Naval Ordnance to any departure from the estimates; to see that all torpedoes, torpedo and electrical fittings and stores are kept in repair and ready for immediate use.

7. On these details he is to communicate departmentally with the Director of Artillery and the captains of the torpedo school ships, keeping the Director of Naval Ordnance informed from time to time as to any important facts.

8. To advise with regard to the designs in ships as well as boats of torpedo armament, and fitting out of torpedo-boats, and to see that they are supplied and fitted in accordance with the approved regulations as far as regards torpedo and electrical fittings.

9. To prepare programmes when required for submarine mining practice and manœuvres to be carried out by Her Majesty's fleet and torpedo-boats, and suggest any particular points which require working out.

10. To furnish the Intelligence Department from time to time with such information as they may require in regard to torpedo questions.

11. To visit, as may be considered necessary, under the directions of the Director of Naval Ordnance, the various torpedo depots and manufactories so as to make himself personally acquainted with the progress and state of the work, and to attend such trials and experiments as may be necessary.

12. To consult personally with the Director of Naval Construction, Director of Dock-yards, and Engineer-in-Chief, and Director of Stores on any matters relating to his work so as to facilitate business and prevent misunderstandings and delays.

13. To act and sign for the Director of Naval Ordnance in his absence.

14. It is to be understood that the Director of Naval Ordnance will continue to be primarily responsible for all work of his department, as laid down in his instructions of 13th December 1883, and all communications to the Controller or the Board are to be sent through him.

(*f*) *Director of Stores.*

A memorandum was prepared for the purpose of defining the duties of Superintendent of Stores, which memorandum was, however, never officially issued.

The following is a copy of the memorandum, which correctly defined the duties of the Superintendent of Stores * as they were up to 19th March, 1872.

The Superintendent of Stores is responsible under the superintendence of the Third Lord and Controller for the performance of the following duties:

1. He is responsible for the maintenance of supplies of naval stores in Her Majesty's dock-yards and depots, for the control of the issue, transfer, and survey of stores, and the conversion, condemnation, and disposal of such as are useless. He is to see that the supplies are adequate to the wants of Her Majesty's service, but not excessive, so as to prevent, so far as possible, any deterioration.

2. He is to obtain and record information as to the state of the stores in the different yards (both as regards quantity and quality); as to the state of the liabilities on the vote, and the payments made; also as to the requirements of the different yards, and the best means of obtaining stores.

3. He is to watch the expenditure on the vote for naval stores; to prepare the estimates as to the quantity and costs of each kind of store required, and to propose the distribution of the store to the different establishments.

4. He will make requisition, when necessary, on the superintendent of contracts for the purchase of stores, and the sale of old stores; obtaining the approval of the Third Lord and Controller, except in cases of purchase where the estimated cost does not exceed £50, and the stores are not of an exceptional character.

5. He is to assist in watching the delivery of goods purchased; he is to superintend transfers of stores from one home yard to another; to advise upon the movements of store ships and yard craft; to propose to the Third Lord and Controller such shipments to foreign yards as may be necessary, and to see that the shipment of stores takes place without delay. He is to make requisition on the Director of Transports for the conveyance of stores issued from the yards to foreign stations, giving early notice of the quantity of tonnage required.

6. He is to keep himself informed by letters of advice or other returns from the officers of all local purchases of stores, and he is to examine into such purchases (except as regards cost).

7. He is to see that inventions relating to articles of naval stores are properly reported on and tried.

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*In November, 1876, the title of "Director of stores" was substituted for that of "Superintendent of Stores."

8. He is to visit the dock-yards and inspect the store-houses, to see that they are kept in proper order, and the stores well arranged and ready for issue; he is to inspect the store ledgers and examine into the quantities of stores in hand,

9. He is to examine the naval-store accounts of the commanding officers of Her Majesty's ships.

10. All correspondence relating to the performance of his duties will be conducted in the Naval Store Branch, except correspondence arising out of the requisitions for purchase or sale of stores and conveyance of stores purchased, which will be managed by the Superintendent of Contracts, and that relating to matters of account, which will be managed by the Accountant-General. He is authorized to sign any routine letters relating to stores.

11. He is to bear in mind that he is not to act in any manner of importance without obtaining superior authority.

PRINCIPAL ALTERATIONS MADE IN THE DUTIES OF THE DIRECTOR OF STORES SINCE 1872.

October 20, 1871.—List of stores overdue ordered to be furnished to the Superintendent of Contracts instead of to the Superintendent of Stores.

February 7, 1873.—The duty of preferring claims was transferred from the Superintendent of Stores to the Accountant-General.

1876.—The control of the store-house staff of the dock-yards placed under the Director of Stores, and also the preparation of the examination papers, and examination of candidates's answers.

November 27, 1876.—The title of Director of Stores to be substituted for that of Superintendent of Stores.

August 3, 1877.—The Director of Stores authorized to send all demands for stores to the Directors of Contracts without further authority, provided that the subhead of the vote be not thereby exceeded.

April 1, 1879.—Transport mess articles hitherto provided by the Transport Department (at the cost of vote 17) transferred to the Director of Stores, to be charged to vote 10, section 1. Now vote 8, section 2.

December 24, 1879.—Clerical store staff at the dock-yards at home and abroad to be considered part of the store office at the Admiralty, and to be interchargeable therewith.

January 15, 1880, *and May*, 1880.—Stores required by the works department at the yards (with the exception of special articles, such as iron roofs, girders, etc.), to be provided by the Director of Stores.

May, 1880.—Control of labour on storekeeping and handling stores placed under Director of Stores.

February 22, 1883.—Requisitions under the value of £100, for stores not provided for in the estimates, may be approved by the Director of Stores, provided that the vote be not thereby exceeded; a fortnightly return of such amounts to be furnished to the Controller of the Navy.

October, 1885.—Management of the stock-taking of stores at the dock-yards transferred from the Accountant-General to the Director of Stores.

5th Feb., 1886.—Examination of store accounts of ships, etc., transferred from Accountant-General to Director of Stores.

(*g*) *Inspector of Dockyard Expense Accounts* (*dated* 5*th April*, 1887).

The Dockyard Expense Branch, hitherto conducted in connection with the Accountant-General's department, is for the future to be associated with the Controller of the Navy's Department, and to be placed under his control. The duty of the branch is to keep a constant and close record of all expenditure at the dockyards, with a view to such outlay being promptly and specifically charged to the particular work or object to which it was applied. Especial regard is to be paid to such allocation of expenditure, under various heads and sub-heads, as will facilitate a control over the outgoings, by enabling such comparisons and checks to be established that the Controller of the Navy can at any time watch the progress of expenditure in labor and materials over all work. The branch will supervise the expense account, so that the progress of expenditure, in comparison with the estimates, or authority for expenditure, may be closely watched by the Controller of the Navy.

In order that the system of charging to each work or head of expenditure, as quickly and accurately as possible, the amount expended, the Inspector of Expense Accounts will submit to the Controller of the Navy from time to time any proposals for alteration in the system of the dockyards that he thinks best calculated to achieve this object.

The Dockyard Expense Branch of the Controller of the Navy's Department will be charged with dealing with all matters that relate to dockyard and other expenditure, for which that department is responsible, *i. e.*, the cost of ships, manufactures, etc.

The Inspector of Dockyard Expense Accounts will be immediately responsible to the Controller of the Navy for the direction of the duties of this branch, as well as of those connected with the collection of the details of expenditure and with the compilation of the expense accounts, etc., at the dockyards. He will frequently visit the yards, whereat he will act with the authority of, and as representing the controller in all matters connected with the expense accounts or similar records of expenditure, including the appropriation of labor and materials, and with the distribution and employment of the clerical staff thereupon.

He is to be responsible that all the expense accounts and similar returns relating to the Controller's department are properly and promptly prepared, that they are clear and trustworthy, that expenditure is charged to proper headings in the expense accounts relating to ships and yard services, and that it is in accordance with proper authority; and it will be his duty to review and report upon expenditure for which the Controller is responsible, especially with regard to such as can not be debited to the cost of ships and manufactures.

He is to furnish the Controller and heads of the several executive branches of his department with such statistical information relating to the dockyards and the cost of ships, etc., as may from time to time be necessary. He will also furnish, through the Controller, such information upon these subjects as may be required by their Lordships and the Financial Secretary.

He is to keep such books and records as may be requisite for statistical purposes and for the preparation for Parliament of the expense accounts relating to ships, manufactures, etc., and for the annual reports thereon, also for the registration of papers appertaining to the above business.

He is to be promptly afforded, at the Admiralty and dockyards, the fullest information he may require, and he is authorized at all times to call for and to have access to all yard books, papers, etc., bearing upon all dockyard estimates for ships and services and expense, etc., accounts.

For purposes connected with the above duties he will communicate direct with the heads of departments at the Admiralty and with the Superintendents of the Dockyards, signing "for the Controller."

He is to have the fullest personal communication with the officers of all departments at the yards, who are to afford him (and such officers as may be appointed to assist him) every information and facility in the execution of his duties.

(*h*) *Accountant-General.*

[Office Memo., 10th December, 1885.]

1. I am commanded by my Lords to annex, for the information of the several departments of the Admiralty, a copy of Her Majesty's Order in Council, dated 18th Novem-

ber, 1885, defining the functions of the Accountant-General of the Navy, and authorizing him to act under the Parliamentary and Financial Secretary as his deputy and assistant; and enabling him to furnish the Parliamentary and Financial Secretary with the means of exercising an independent financial control over naval expenditure, whether of an ordinary or extraordinary character.

2. It will be the duty of the Accountant-General—

(1) To criticise the annual estimates as to their sufficiency before they are passed, and to advise the Parliamentary and Financial Secretary as to their satisfying the ordinary conditions of economy.

(2) To financially review the progress of liabilities and expenditure under the estimates.

(3) To consider, in regard to dockyard expenditure, the proposed programme of construction, etc., that is, in regard to labor, material, and machinery.

(4) To review the current expenditure or employment of labor and material, as distinguished from cash payments at the yards.

(5) To review proposals to spend money on new work, or repairs of any kind, for which estimates are currently proposed.

While these functions will enable the Accountant-General to assist the various departments to watch the progress of current expenditure, which is an indispensable condition of financial order, they will in no way interfere with the proper administrative functions of the executive departments.

3. It will be the duty of the several principal officers to keep a careful watch upon expenditure, or credits accruing to the votes under their control, and to keep the Accountant-General accurately informed of all current liabilities. And it will be the duty of the Accountant-General to keep himself thoroughly acquainted with the progress of such liabilities, and obtain such explanations from the various departments as will enable him to appreciate the financial results of these liabilities, and bring to the notice of the Parliamentary and Financial Secretary any matter demanding attention.

He is further empowered to determine the form in which liabilities are to be recorded by the spending departments, and to call upon the departments concerned for explanations in regard to all liabilities incurred on ordinary or special votes.

4. The following regulations are, therefore, to be observed in future, any alterations which may be found necessary being brought under the notice of the First Lord.

PREPARATION OF THE NAVY ESTIMATES.

1. The estimates, before being finally approved, will be discussed at Board meetings.

2. Each member of the Board is to be furnished with the estimate at least two days before the meeting of the Board at which such estimate is to be discussed.

3. The heads of departments are to be prepared to attend in the Board room when summoned while the votes for which they are respectively concerned are being considered.

4. In order that the Accountant-General may become possessed of the requisite information as to their Lordships' views and intentions with respect to the bases and amount of each vote of the navy estimates the Accountant-General will be required to be present on the occasion of each vote receiving their final approval.

The following detailed arrangements are to be observed for the purpose of obtaining such approval.

5. It is not intended by these arrangements to prevent in any way any department bringing under their Lordships' notice any question which may arise in the preparation of the votes which it controls; but my Lords require the written concurrence of the Accountant-General to each vote before it is finally approved. This will secure that the Accountant-General has been informed of all the facts connected with each vote, and that he is in a position, from a financial point of view, to certify to its accuracy.

The following statement* indicates the course pursued in the preparation of the navy estimates:

VOTE A.—*Numbers.*

Prepared by Accountant-General from numbers decided by their Lordships, and sanctioned by order in council, as regards officers, seamen, boys, and Coast Guard.

The Deputy Adjutant-General is consulted with respect to the Royal Marines, for whom there is an establishment of 12,900, fixed by order in council of 26th June, 1886. Any variation from the foregoing requires similar sanction.

VOTE 1.—*Wages of officers, seamen, etc.*

This vote is prepared by the Accountant-General from the numbers shown in vote A at authorized scales of pay and allowances, some of the items, *e. g.*, contingencies, Coast Guard, recruiting expenses, etc., being based on past expenditure.

Salaries, etc., royal marine divisions.—According to fixed rates of salaries and allowances.

Half-pay.—Based on authorized rates and probable numbers.

VOTE 2.—*Victualling and clothing for the navy.*

The Accountant-General prepares the items relating to salaries, police, wages of naval men, extra pay, rents, and contingencies. Gas and water by Director of Works.

The remaining items are prepared by the Director of Victualling, viz: Wages of artificers, crews of yard hoys, provisions, mess traps, etc., and are referred to the Accountant-General for financial criticism before being submitted to their Lordships.

The Director of Victualling concurs in the vote as a whole.

VOTE 3.—*Medical establishments and services.*

Prepared by Accountant-General as regards salaries and allowances, wages of naval sick-berth staff, police (at home) extra pay, rents, and contingencies, etc.

The Director-General estimates for civilian wages, hospital provisions, miscellaneous disbursements, etc., and refers the items to the Accountant-General for financial concurrence. He also concurs in the vote as a whole.

VOTE 4.—*Martial law.*

Prepared by the Accountant-General. The estimates for the prison establishments are based upon authorized scales of salary, and upon the average expenditure in past years as regards other items.

VOTE 5.—*Educational services.*

Prepared by the Accountant-General from information supplied by some of the educational establishments and partly from authorized scales of salary and allowances.

VOTE 6.—*Divine service.*

Prepared by the Accountant-General. The estimate is based upon the authorized numbers and scales of full pay, etc.

VOTE 7.—*Royal naval reserves.*

Prepared by Accountant-General. The Admiral Superintendent of Naval Reserves furnishes the numbers of the various ranks and ratings to be provided for.

The Admiral Superintendent of Naval Reserves concurs in the vote as a whole.

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*The estimates having been prepared in 1888 in a new form, a revised statement has been substituted for that originally issued with that memorandum in 1885.

VOTE 8.—*Shipbuilding, repairs, maintenance, etc.*

Section I. (Personnel.)—Prepared by the Accountant-General as regards salaries and allowances and contingencies, etc. The Controller furnishes the amounts for labor and police.

Section II. (*Matériel.*)—The store items are furnished by the Director of Stores. Other items estimated by Accountant-General.

Section III. (Contract work.)—Estimate prepared by Controller. Estimates for labor and stores, etc., furnished by Controller's Department, to be referred for financial criticism of Accountant-General.

VOTE 9.—*Naval armaments.*

Estimate prepared by Director of Naval Ordnance, and referred to the Accountant-General for financial criticism.

VOTE 10.—*Works, buildings, and repairs at home and abroad.*

Estimate prepared by the Director of Works, except as regards the salaries and allowances of the officers superintending works in progress, which are furnished by the accountant-general.

The items for works are referred for the concurrence of the Controller, and the financial criticism of the Accountant-General.

VOTE 11.—*Miscellaneous effective services.*

The estimate is prepared by the Accountant-General, and is principally upon the average expenditure in previous years, any new items or doubtful points being considered separately.

VOTE 12.—*Scientific services.*

This vote is prepared by the Accountant-General. The salaries of the establishments are based upon authorized scales and numbers of officers.

Information as regards the contingencies of the observatories, expenses of preparing charts, surveys, and chronometers, is furnished by the Hydrographer.

VOTE 13.—*Admiralty office.*

Prepared by the Accountant-General. The estimate is based on the authorized members for each rank, any variations in numbers or scales of salary receiving separate consideration and treasury authority.

VOTE 14.—*Reserved and retired pay.*

VOTE 15.—*Naval pensions.*

VOTE 16.—*Widows' pensions and compassionate allowances.*

VOTE 17.—*Civil pensions and gratuities.*

The foregoing votes (Nos. 14 to 17) for non-effective services are prepared by the Accountant-General, and are based upon the numbers actually in receipt of retired pay or pensions, plus the anticipated requirements of the ensuing financial year.

1. In framing the annual estimates each vote is to be referred in sufficient time, with explanations, to the Accountant-General for concurrence or observations before being submitted to their Lordships for final approval, accompanied by a detailed statement showing the basis of calculation. The same course is to be followed with supplementary estimates.

2. When services of an extraordinary nature not provided for in the ordinary estimates are required to be undertaken, in anticipation of application to Parliament for a vote of credit, the departments are to supply the Accountant-General with estimates of the amount required, after which he will submit the sum required in due form for the consideration of their Lordships.

3. Any proposals for alterations in the classification or arrangement of the votes or subheads of the estimates are to be referred to the Accountant-General for opinion or advice before being carried out.

PROGRESS OF LIABILITIES AND EXPENDITURE.

1. The several departments are to be held responsible for the administration of their respective votes, *i. e.*, for keeping their expenditure within the authorized limits; for seeing that, as far as possible, the estimated receipts are fully realized; and for informing the Accountant-General and their Lordships in sufficient time of any anticipated surpluses or deficits or variations from the credits estimated to be received.

2. In view of the responsibility which will thus devolve upon the several departments in regard to watching closely the progress of their liabilities and disbursements they are to be furnished with such information as may be necessary for securing an efficient control over expenditures under their votes. The information in question is, however, to be as general as possible and free from unnecessary elaboration.

3. To this end the spending departments are to be furnished with the following periodical returns:

(*a*) Statements of liabilities outstanding from the previous financial year, which will become a charge on the votes of the succeeding year, viz: A statement from the Accountant-General, not later than the 6th April, of the value of all stores received and entered on the accounts of receipt during the financial year but not paid for in that year; statements from the receiving establishments, not later than 18th April, of the value of stores ordered for payment in the preceding financial year but not received in that year; a statement from the Director of Navy Contracts, not later than 6th April, of the estimated value of stores demanded, but not ordered, during the preceding financial year.

(*b*) Cumulative statements from the Accountant-General, on the first of each month, of the gross amount of claims made on other departments, etc., up to those dates, compared with the amounts actually received and credited to the votes on account of the same. Final statements are to be furnished, as soon as possible after the accounts for the year are closed, showing the credits outstanding from the previous financial year, which, if recovered, will be appropriated in aid of the vote of the succeeding year.

(*c*) Statements from the Accountant-General, within three days after the close of each month from June to March in each financial year, of payments made by bill up to the end of the preceding month on account of the votes concerned.

4. The Accountant-General is also to refer to the Director of Victualling that portion of the monthly statements of receipts and payments received from the paymasters of Her Majesty's ships and from the cashiers of naval establishments which relates to his vote, and provision is to be made in the same for the following details:

Under payments: (1) Provisions, (2) savings, (3) other charges.

Under receipts: (1) Credits for charges against seamen's wages, (2) credits for charges against marines' wages, (3) other credits.

5. All claims which are made for stores supplied to, or services performed on account of, other departments of government, other navy votes, and private individuals are to be referred as promptly as possible to the several departments concerned.

6. The Accountant-General is to be responsible, as heretofore, for keeping their Lordships acquainted, by means of provisional accounts of naval receipts and expenditure, with the actual and prospective charges to all navy votes.

These provisional accounts will be based upon the figures given by adding the ascertained actual receipts and expenditure of past months of the current year to the anticipated requirements for the remaining portion of the financial year. The special attention of their Lordships should be drawn to cases where the provision in the estimates under votes or subheads of votes is likely to be exceeded.

To enable the Accountant-General to compile these provisional accounts, the spending departments will prepare, immediately after the close of each month, from June to March, revised estimates, showing (*a*) the amount of all orders given and (*b*) the anticipated variations from approved estimates.

These estimates should be furnished to the Accountant-General on the 5th of each month with a brief explanation of anything likely to affect the figures which they contain. Expenditure for special services, paid for out of supplementary estimates, is to be distinguished from that provided for in the ordinary grants of the year.

7. Special statements, with such detailed information as the Accountant-General may request, are to be furnished in the case of expenditure for services for which provision has been made out of votes of credit.

8. When there is a probability of the subhead of a vote being exceeded, and it is found that liabilities are still being incurred at the existing rate of expenditure, the Accountant-General is to warn the department concerned, and, if necessary, bring the subject under the notice of their Lordships.

9. The existing rule that the Accountant-General is to be consulted before any expenditure is incurred which is not provided for in the estimates, or before any money provided in a vote or subhead of the estimates is applied to any purpose other than that for which it was so provided, is to be strictly observed.

10. In communicating their instructions my Lords wish in no way to diminish the responsibility of each department for its own expenditure; but they consider that in recognizing the Accountant-General themselves, and in calling upon the spending departments to recognize him to the fullest possible extent as to the financial officer who should be referred to in regard to all proposals involving expenditure, a security will be given for the economical administration of naval funds, which does not now exist. With this view I am, therefore, to signify their directions that the above regulations are to be brought into immediate operation, and that as to details the departments concerned are to place themselves at once in communication with the Accountant-General.

11. This order supersedes previous instructions in regard to the functions of the Accountant-General.

At the court at Windsor, the 18th day of November, 1885.

Present: The Queen's most Excellent Majesty in Council.

Whereas there was this day read at the Board a memorial from the right honorable the Lords Commissioners of the Admiralty, dated the 14th day of November, 1885, in the words following, viz:

"Whereas by an order in council of the 13th day of October, 1832, the functions of the Accountant-General of the navy were defined; and whereas by Your Majesty's subsequent orders in council of the 14th day of January, 1869, and the 19th day of March, 1872, certain alterations were approved by Your Majesty in the constitution of the Board of Admiralty affecting its financial arrangements by the appointment of the Parliamentary and Financial Secretary to be responsible to the First Lord for the finance of the department; and whereas it is, in our opinion, desirable to afford him assistance in the discharge of these important duties, we would humbly recommend to Your Majesty the appointment of the Accountant-General of the Navy to act as an Assistant to the Financial Secretary.

"We are most humbly of opinion that while the executive departments of the admiralty should continue to be held primarily responsible for keeping a careful watch upon the expenditure they recommend or incur, the Accountant-General should be authorized to act under the Parliamentary and Financial Secretary as his deputy and assistant.

"With this object he should be charged under the Parliamentary and Financial Secretary with the preparation of the naval estimates; with financially reviewing the expenditure under those estimates; with advising or deciding as to any redistribution of votes or transfers which may from time to time be found necessary; with satisfying himself that such expenditure is properly allowed and brought to account; with advising on all questions affecting naval expenditure; and that he should not only be made acquainted with expenditure after it has been incurred, but be regarded as the officer to be consulted on all matters involving an expenditure of naval funds.

"We therefore most humbly submit that Your Majesty will be graciously pleased to sanction this arrangement."

Her Majesty, having taken the said memorial into consideration, was pleased, by and with the advice of her Privy Council, to approve of what is therein proposed, and the right honorable the Lords Commissioners of the Admiralty are to give the necessary directions herein accordingly.

C. L. PEEL.

(*i*) *Director of Navy Contracts* (*dated 9th March* 1888).

The Director of Navy Contracts is responsible for the purchase of all stores, supplies, and machinery required for the use of Her Majesty's naval and marine forces and establishments, and for the conclusion of all contracts in connection therewith, excluding only contracts for ships and propelling machinery, and the following requirements of the Director of Works, viz: Purchases not exceeding £100 in value. Cement, materials, and machinery of a nature not used in the dockyard department.

These exceptions, with the contracts for new works and repairs, will remain under the charge of the Director of Works.

The Director of Navy Contracts will also sell old ships and old stores of every kind.

He will be guided in his action by the following regulations:

1. Requisitions for the purchase of stores are to be accompanied by full particulars as to pattern, make, description, and quality of the articles demanded, and when the article is of a new design or special character he is to be furnished with a carefully-prepared specification and such drawings or patterns as he may consider necessary for the guidance of manufacturers.

2. On receiving a requisition he is to make the contract, or purchase or sell the stores, as the case may be, at such times as may be deemed advisable: (*a*) By calling for tenders by public advertisements; (*b*) by inviting tenders from selected firms; (*c*) by direct negotiation in special cases, or in any emergency; (*d*) by purchase through a broker or sale through an auctioneer.

In selecting the course to be followed he is to be governed by the general scheme of purchase approved by their Lordships on 13th July, 1883, which is to be reviewed annually.

3. Whilst every attention is to be given to purchasing at the lowest possible prices, the quality, durability, and suitability of the article is to be considered of even more importance than the cost.

4. To insure the supply of articles of satisfactory quality care must be taken to obtain them only from persons or firms of repute, and for this purpose the system of limited tenders should be encouraged in preference to general invitations by advertisements. In such case, other matters being equal, the principle of accepting the lowest offer should prevail.

As regards machinery and special articles he is to confer with the head of the department concerned as to the firms to be invited to tender.

5. Applications from persons desirous of being placed, or whom it is proposed to place, on the selected lists, and the names of those whom it is proposed to omit therefrom, are to be submitted to the Financial Secretary for his approval, and all appeals, or redress, or reconsideration on the part of contractors are to be referred in a similar manner before a final adverse decision is communicated.

The utmost facility is to be given to all who give satisfactory evidence as to their means of production, character, and reliability of their manufactures or supplies to be placed on the selected list of those who may be invited from time to time to tender.

The heads of departments may from time to time communicate to the Director of Navy Contracts the names of persons from whom they consider tenders may be invited.

If any who are thus placed on the selected list continuously fail to tender when invited, or to make reasonable offers, the attention of the Financial Secretary is to be called to the fact with a view to his determining whether they are to remain on such list.

6. In calling for public tenders the Director of Contracts is to insert the necessary advertisements in newspapers upon the list authorized by the treasury, taking care to select such newspapers only as will give the greatest publicity. As advertisements may not in all cases be observed by those from whom it would be desirable to obtain offers, copies of the form of tender are to be sent by post to all such firms who may notify their desire to have them, and to such others as he may determine, the receipt or forms of tender not to be regarded as affecting the discretion of the Admirality in dealing with the same as the board may see fit.

7. In cases of purchase by broker, or sale by an auctioneer, he is to issue the necessary directions to the persons approved to act for such purposes.

8. The time of purchase is to be regulated by the season at which the articles can be obtained most favorably as regards quality and price.

9. In purchasing supplies he is to conform as far as possible to the customs and conditions of the trade, having regard to any necessary stipulations for quality which the circumstances of the service may require.

10. Tenders are to be made under sealed cover, addressed to the Director of Navy Contracts, marked "Tender for ———," and must be delivered at or before the hour indicated in the invitation, after which time no tender is to be received. The tender box is to be in his charge and all tenders are to be lodged in it. Instructions will be given from time to time by the First Lord or Financial Secretary as to the procedure to be observed in opening and tabulating tenders. No tenders are to be opened until after the hour indicated for receipt.

The Director of Navy Contracts will inform the Financial Secretary weekly of the days upon which tenders are to be received in the current week, in order that he may indicate those at the opening of which he can conveniently attend.

11. Tenders when opened are to be tabulated, examined, considered, and the recommendation submitted for the approval of the superintending Lord concerned and of the Financial Secretary with all possible dispatch after receipt.

In regard to any tenders received for special articles, or for supplies as regards the nature or quality of which he may desire advice or information, or as to which the head of the department concerned has expressed a wish to be consulted, he is, before submitting a tender for acceptance, to obtain the opinion of the head of such department.

12. When the acceptance of a tender is so urgent as to prevent the ordinary procedure being strictly followed, he may, without previous sanction, accept the lowest tender, and decide upon any offers respecting which, in his opinion, immediate action is required. In such cases he will, at the earliest moment, report the steps taken to the superintending Lord concerned and the Financial Secretary, indorsing on the papers the reason why such special action was necessary. He may, under similar conditions, purchase stores urgently required.

13. He may purchase stores demanded that do not exceed £100 in value, on his own authority, in such way as he may consider best in the public interest.

He may also order goods of the same description at the rates of a previous purchase for the same financial year without prior or subsequent approval.

A return, giving particulars of all purchases made and extensions of orders given under the above authority, is to be submitted periodically to the Financial Secretary for approval as he may direct.

14. So soon as a contract has been concluded he is to forward the tenders and papers connected therewith to the Head of the Department concerned and to the Accountant-General. Claims will be under the sole charge of the Accountant-General, and the record of stores due will be kept at the receiving yards.

15. Heads of Departments, through their local officers, are primarily responsible for securing fulfillment of contracts and delivery of purchases by the agreed times. In the event, however, of delay and unsuccessful applications for completion having been made, full particulars are to be given by the establishments to the Director of Navy Contracts, and he is to take steps to secure delivery by exercising pressure upon the contractors. Before buying in default, the Financial Secretary is to be consulted.

16. The Director of Navy Contracts has no responsibility for the examination of stores, but it being necessary for the proper performance of his duties that he should be generally acquainted with the character of goods supplied by contractors, he will be furnished by the examining officers with such information and reports upon their quality as he may from time to time desire.

He is also authorized to obtain, through the Head of the Department concerned, samples from store of goods supplied, with the view of subjecting them to independent examination in comparison with the standard.

17. Complaints by users as to the quality of stores will be referred to him by the Head of the Department concerned, with full particulars of the source of supply. He is to investigate and report upon the facts, and record the results. In the event of the Director of Contracts having reason to question the action of a surveyor of stores as to the receipt or rejection of stores, he must do so through the Head of the Department concerned.

18. No stores are to be accepted by the examining officers at an abatement or that are not up to standard without the approval of the Head of the Department concerned, and the concurrence of the superintending Lord and Financial Secretary obtained through the Director of Navy Contracts.

19. In the event of the examining officers considering that so large a proportion of a delivery of goods ought to be rejected as to warrant the rejection of the whole, an immediate communication giving the reason for such proposed rejection is to be made to the Head of the Department concerned. If the proposed rejection is approved by the Head of the Department, the Director of Navy Contracts is to be furnished with full particulars, in order that he may communicate with the contractors thereon. A list of all rejections of importance is to be sent monthly to the Director of Navy Contracts.

20. He is to keep a register of all persons from whom supplies are received, in which he is to record complaints made and substantiated as regards default in delivery or inferiority in quality.

21. In connection with his duties as purchasing officer for the departments, he is to keep himself well informed of improvements and changes in the designs or qualities of the different stores required, and is to call the attention of the Heads of Departments to all such modifications, as well as new inventions, as may secure to the service the best and most suitable articles.

22. To enable him to give effect to the foregoing, he is to visit the several establishments and sources of supply as frequently as possible. Frequent communications with private users should also be made.

23. In the month of December in each year, he is to request the Heads of Departments to call upon the examining officers and principal users of the establishment under their direction, to report whether they have been satisfied with the way in which the contracts for the current year have been fulfilled, and to name the firms who have not reasonably fulfilled their obligations either in quality or delivery, with general particulars of their default.

On receipt of these reports he is to duly consider them, and recommend to the Financial Secretary whether future tenders should be entertained from the firms so complained of or not.

24. In order to insure that the conditions of purchase shall be such as to secure the article best adapted for the service, he is to consult the Head of the Department concerned, whenever it is proposed to renew a contract of importance, as to whether any alterations are desired. He is, in addition, to inform himself as to the general conditions of purchase prevailing in the respective trades, and suggest such modifications as may seem desirable.

25. Contracts should, whenever practicable, be made for specific quantities. If entered into for quantities deliverable on demand, they should, as a rule, be concluded for one year certain, and provision be made for their termination at the end of three months' notice given at any time after the expiration of the twelve months. Such contracts should not, as a rule, be permitted to run more than three years without being again thrown open to competition.

A list of these contracts is to be reported yearly to the Financial Secretary.

26. The conditions of arbitration embodied in the agreement of arbitration is to attach to every contract of manufactured articles or stores bought out of stock in this country.

As regards raw materials purchased abroad and sent direct to the yards, permissive power may be given to the arbitrators to determine if any and what abatement should be made for supplies not up to the specified standard, but, nevertheless, considered to be of suitable quality. In the event of the abatement awarded being in excess of 5 per cent. on the purchase price, the Financial Secretary shall have the sole power to decide whether the stores are such as are fit and serviceable for the purpose for which they were purchased, and shall be accepted on the proposed terms.

27. The stipulation in a contract as to pattern or quality is to be regarded as the minimum standard for delivery, except as provided in 26; and he is to call the attention of Heads of Departments to any patterns provided which may be considered of any unnecessary high standard of finish and impossible of fulfillment without adding greatly to the cost.

28. Whenever he considers that it is to the advantage of the service that supplies for all the yards should be delivered at any one place for examination and subsequently distributed therefrom, he is to submit his proposition to the Head of Department concerned and to the Financial Secretary.

29. He is to draw the attention of the Heads of Departments to any supplies of materials and stores which can be obtained locally abroad at cheaper rates, or to greater advantage, than by shipment from this country.

30. To obviate the necessity of maintaining excessive stocks, he is to keep prepared all information necessary to enable him to order and obtain at the shortest possible notice such quantities of stores and supplies as may be required in an emergency, and to advise the Heads of Departments as to the time that must necessarily elapse between the receipt of the requisition and the date at which delivery may be relied on.

31. In the event of contractors tendering goods that exceed those ordered by 5 per cent. in quantity, or £50 in value, the excess is not to be accepted without reference to the Head of the Department and to the Director of Navy Contracts, and also to the Financial Secretary if the surplus exceeds £100 in value.

32. Letters of advice of purchases or vouchers for stores purchased and sold abroad, and the monthly returns of local purchases of stores made in different home establishments, are to be referred to the Director of Navy Contracts for inspection as to prices, and he is to be careful to require full explanations of the steps taken to procure or sell stores on the best possible terms in all cases where the rates paid seem too high, or insufficient prices appear to have been realized.

33. He is to furnish to the department concerned full information of the results of sale of old ships and stores, the account of sale itself going to the Accountant-General as heretofore.

34. As a general rule he is to conduct all correspondence relating to contracts, purchases, and sales under his control. On all matters of detail connected with the duties of his office he may correspond in his own name with individual officers of Her Majesty's navy or civil service, and with subordinate departments of Her Majesty's Government, and with contractors or other such persons; but all communications of importance will be signed by the Secretary.

35. The present practice, where not incompatible with these instructions, is to be regarded as in force.

(*j*) *Medical Director-General.*

By the Commissioners for executing the office of Lord High Admiral of the United Kingdom of Great Britain and Ireland, etc.

To ——— ———, hereby appointed director-general of the medical department of the Navy:

By virtue of the power and authority to us given, we do hereby constitute and appoint you to be one of our principal officers for conducting and assisting in the ordinary details of the business of the civil department of Her Majesty's naval service, under the immediate superintendence of one of our said Commissioners; the appointment not to exceed five years, and within that period to be during pleasure; willing and requiring you to take upon you especially the charge and duties of Director-General of the Medical Department of the Navy, and to obey all such instructions as you may from time to time receive from us for your guidance in the execution of the duties of that department, strictly charging and commanding all persons employed subordinate to you to behave themselves jointly and severally with all due respect and obedience to you as one of our principal officers before mentioned, and for your care and trouble in the execution of the duties of your office, you will be entitled to receive a salary of thirteen hundred pounds per annum until further orders, and for so doing this shall be your commission.

The salary of £1,300 a year will be inclusive of any naval pay or allowances, and you will have no claim to either civil pension or gratuity on the expiration of your term of office.

Given under our hands, and the seal of the office of Admiralty this ——— ——— 188–.

By command of their Lordships.

(*k*) *Admiral Superintendent of Naval Reserves.*

My Lords Commissioners of the Admiralty having under the provisions of Her Majesty's order in council of the 12th December, 1874, been pleased to appoint you, during pleasure, and in any case for a period not exceeding three years, to be Admiral Superintendent of Naval Reserves, and the Coast Guard, including: (1) Coast Guard afloat in district ships and cruisers. (2) Coast Guard on shore. (3) Royal Naval Reserve. (4) Royal Naval Artillery Volunteers. (5) Seamen Pension Reserve.

The following will be your instructions:

1. You will, in co-operation with the Commissioners of Customs and Board of Trade, take all measures necessary for the protection of the revenue, for saving and guarding life and property from wrecks, etc., and for the protection of fisheries; governing yourself in your correspondence with the Board of Trade by their Lordships' order of the 5th March, 1875.

2. You will hoist your flag on board the district ship at Portland, and proceed from time to time, as you may deem expedient, to inspect the district ships and stations on

shore of the Coast Guard, also the drill ships and batteries of the naval reserve, and the several brigades of Royal Naval Artillery Volunteers, taking care to keep their Lordships fully informed of your intended movements.

3. You will communicate to the officers placed under your supervision any orders and instructions you may receive from their Lordships relating to the before mentioned services, and you will take care to keep their Lordships informed on all points as regards their organization, and the measures you may consider advisable for maintaining their efficiency.

4. Questions relating to the Coast Guard buildings will be dealt with in the Department of the Director of Works, under authority from their Lordships; but it is desirable that you should freely communicate to my Lords your views with regard to any repairs, alterations, any improvements you may think desirable in such buildings; and the Director of Works will be instructed to refer to you for your opinion in any questions of new sites for buildings or of extensive repairs.

5. Questions as to the repairs of ships and boats, and the supply of stores of all descriptions, will be dealt with in the departments of the Admiralty to which such matters appertain.

6. Important legal questions and those relating to discipline, will, in like manner, be dealt with in the legal branch of this office.

7. All formal submissions from you, on subjects requiring their Lordships' decision, are to be addressed to the secretary of the Admiralty.

8. Any movement of a district ship from her assigned station will be ordered by you, on receiving instructions from their Lordships.

9. All first appointments of officers and men to the Coast Guard will be made by their Lordships.

10. Promotions to the rank of Chief Officer and removals from one station to another of Inspecting Officers of divisions will be regulated by their Lordships, on submissions to be made by you.

11. All promotions below the rank of Chief Officer, and the stationing of Chief Officers, and of all men below that rank will be made by you on your own responsibility.

12. Questions as to travelling expenses are to be decided by you, in conjunction with the Accountant-General, if according to regulations, and only exceptional cases are to be referred for the decision of the Superintending Lords.

13. All papers on which a letter is addressed to you by the Secretary of the Admiralty will be lodged in the central record office. Papers as to payment of expenses will be retained in the Accountant-General's office, and all others will be kept in the Naval Reserves Office itself.

14. Letters, etc., addressed to the Admiral Superintendent of Naval Reserves at Spring Gardens will be delivered free of charge; and letters, etc., sent from the Naval Reserves Office will be franked.

15. As their Lordships desire to assist the Mercantile Training Ships, as far as possible, by admitting such of the boys whose conduct and training have proved satisfactory, either into the Royal Navy or Royal Naval Reserves, you will, with the consent of the Committee of Management of those institutions, visit the ships occasionally and ascertain whether the routine of instruction is such as to fit the boys for a seafaring life.

16. With respect to the District Ships you will take care that they are kept efficient and ready for immediate service, and that arrangements are in readiness for their seagoing complements being completed by the Fleetmen, if requisite, at the shortest notice.

(*m*) *Director of Naval Intelligence* (*dated* 24*th January*, 1887).

1. The functions of the Intelligence Department are to be purely advisory and in no sense administrative. The essence of its work is to be "preparation for war." The Senior Naval Lord will supervise the intelligence department, but the Director of Naval Intelligence will apply to the other Naval Lords on all matters which are connected

with their duties in the distribution of business, will furnish them with any information which they may at any time require, and take care that they are put in possession of all intelligence received by the department with which they should be acquainted.

2. The duties of the Intelligence Department are as follows:

(*a*) To collect, sift, record, and lay before the Board all information relating to maritime matters likely to be of use in war.

(*b*) To prepare and keep correct to date a complete plan for mobilizing the naval forces of the empire with the utmost possible rapidity, and with the least strain on the Admiralty.

(*c*) When directed, to prepare plans of naval campaign for the consideration of the board.

(*d*) To bring to the notice of the Board all points affecting "preparation for war," but it is to be distinctly understood that the Intelligence Department is not to indicate to the Board any policy in connection with ship building, armaments, etc., unless called upon to do so.

3. In the execution of these duties the main objects to be kept in view are:

(*a*) To obtain a complete knowledge of the naval resources of foreign nations, their preparedness for war, and their ability to maintain a naval war.

(*b*) To record all information in a convenient form and that of most importance so as to be available at short notice.

(*c*) To keep commanders-in-chief and commanding officers supplied, as may be directed, with all such important information as shall be considered by the Board likely to be of use in war.

4. The following information is to be always immediately available: (*a*) Distribution and condition of foreign vessels of war in commission and in reserve; (*b*) distribution of fast foreign mercantile steamers; (*c*) distribution of fast British mercantile steamers; (*d*) personnel of foreign navies in reserve; (*e*) state of the coast defenses of the principal European powers; (*f*) state of defenses of British coaling stations; (*g*) number of British vessels of war ready for commission and that could be got ready in a given time; (*h*) number of officers and men available for manning (*g*).

5. The Staff of the Intelligence Department will be as follows:

One admiral or captain, with the title of Director of Naval Intelligence.

Intelligence division.—One captain, R. N., with the title of Assistant Director of Naval Intelligence; two commanders or lieutenants, R. N.; three marine officers, one higher division clerk, three lower division clerks, one writer.

Mobilization division.—One captain, R. N., with the title of Assistant-Director of Naval Intelligence; two commanders or lieutenants, R. N.; one assistant pay-master, R. N.; one lower division clerk.

The foregoing is the general distribution of the staff, but the Director of Naval Intelligence, with the approval of the Senior Naval Lord, may make any alteration which the exigencies of the time may render desirable.

6. The Director of Naval Intelligence will arrange the details of the work in each division, and the captain in charge will be responsible to him for the work of his division.

7. The clerical staff of the Intelligence Department will be under the control and direction of the Director of Naval Intelligence, in all that relates to the work of the department.

8. All points connected with mobilization which are dealt with by members of the Board are in the first instance to be referred to them for their consideration.

9. All other papers emanating from the Intelligence Department are to be marked to the Secretary and Senior Naval Lord.

10. The Director of Naval Intelligence may communicate departmentally with the Deputy Quartermaster-General, Intelligence Branch, War Office, as heretofore.

11. The Director of Naval Intelligence may communicate with all other departments of the Admiralty, through the Heads of the Departments, on matters relating to the work of the Intelligence Department; but all correspondence with the fleet, government departments, or individuals, will be dealt with by the Secretary of the Admiralty.

12. During the first week in each month (and as much oftener as may be considered necessary) the Director of Naval Intelligence will meet the Naval Members of the Board and the Permanent Secretary, and report to them generally the progress that has been made by the Intelligence Department since the last meeting, and the work he proposes to take in hand during the ensuing month. He will also present a schedule indicating the subjects treated of in the department since the last meeting, to enable the members of the Board to be aware of the existence of such papers, and to obtain the details if required. He will also at these meetings draw the attention of the Board to all existing deficiencies in personnel and *matériel* which may affect the prompt mobilization of the fleet.

13. The Director of Naval Intelligence will consider and submit from time to time suggestions for improving the mode of obtaining naval intelligence in peace and also for obtaining information of any enemy's naval proceedings in war.

14. In the absence of the Director of Naval Intelligence, the Senior Assistant Director of Naval Intelligence will act for him.

(*n*) *Director of Greenwich Hospital* (*dated June*, 1886).

1. To deal with all matters relating to the administration of Greenwich Hospital estates, revenues, and school, submitting such questions to the Civil Lord or Council as may be necessary.

2. To report and advise as to the property in the north, in Greenwich, and at the Isle of Dogs; to confer with the solicitor and to communicate with the local agents when requisite.

3. To act with the Accounting-General or Deputy Accountant-General of the Navy joint attorney on behalf of the Lords Commissioners of the Admiralty for sales of stock. To attend to purchases of stock.

4. To visit the northern estates and the property in Greenwich and the Isle of Dogs when necessary.

To inspect from time to time the collection of works of art, relics, plate, etc., at Greenwich, the property of Greenwich Hospital, and to report to the Board any matter that may seem to him to need attention.

5. To deal with the application of widows of seamen and marines, etc., killed, slain, or drowned in the service of the Crown, for pensions or gratuities out of Greenwich Hospital funds, and allowances for their children; and with claims for gratuities to parents and other relatives of seamen and marines, etc., consulting with the civil branch when necessary.

6. To approve or otherwise of all demands within the limit of £100. (Demands above this limit to be submitted to the Civil Lord for approval.)

7. To receive half-yearly estimates of expenditure on the estates in the north and in Greenwich, and the Isle of Dogs, approving outlay within the limit of £100 as above.

8. To be personally responsible for the conduct of the business generally, and to supervise the economical expenditure of Greenwich Hospital moneys.

9. To have charge of all deeds and documents relating to the hospital and the estates, depositing for safe custody at the Bank of England mortgage, deeds, and other valuable securities, access to the box containing the securities being obtained only by letter to the chief cashier, signed by the First Lord and the Civil Lord for the time being.

10. To receive and register all letters on Greenwich Hospital business and conduct the correspondence, signing as "Director of Greenwich Hospital," obtaining superior authority when necessary.

11. Letters, etc., relating to Greenwich Hospital business to be addressed to the "Director of Greenwich Hospital, Admiralty."

12. To be charged with the due and prompt collection of the revenue of the hospital from all sources, forwarding drafts to Her Majesty's Paymaster-General, in whose favor they will be drawn.

13. To audit the award of Greenwich Hospital age and special pensions.

14. To record all transactions relating to capital and income in accordance with the system of double entry in use in the public service.

15. To examine the cash accounts and vouchers of the northern estates, Greenwich Hospital school, and Her Majesty's Paymaster-General.

16. To examine contractors' and other claims and assign the same for payment.

17. To sign orders on Her Majesty's Paymaster-General, as "Director of Greenwich Hospital." In his absence the clerk in charge will act for him.

Orders for sums exceeding £200 to bear also the signature of one of the Lords of the Admiralty, or another member of the Council.

18. To keep registers of the estates in the north and at Greenwich, and the Isle of Dogs, from which the rent and interest rolls for the northern and Greenwich estates are to be examined.

19. To keep a register of the men maintained in naval hospitals at the expense of Greenwich Hospital funds; to prepare a claim for the naval pensions withheld from the men whilst so maintained, and verify the claim made on Greenwich Hospital funds for such maintenance.

20. To conduct the audit of the provisions, wages, and store accounts at Greenwich Hospital school locally and of the mining royalties on the northern estates.

21. To prepare the annual accounts of the capital and income for examination by the Exchequer and Audit Department for presentation to Parliament.

22. To prepare the annual estimate of Greenwich Hospital and school for presentation to Parliament.

23. To be a member of the several committees of selection for Greenwich Hospital school, for orphanages (boys or girls), and for the Greenwich Hospital educational grant of £20 per annum to the children of deceased or distressed commissioned officers.

24. To receive, register, and examine all applications, and conduct the necessary correspondence connected with the several committees.

25. To arrange for the meetings of the several committees, preparing the classified registers of applications according to the regulations in force for the time being.

26. As member of the committee of inspection at Greenwich Hospital school, to arrange for their annual visitation; also to visit the school periodically, and to accompany the president of the Royal Naval College in his quarterly visitation.

ADMIRALTY ADMINISTRATION.

FIRST LORD.	FINANCIAL SECRETARY.	All departments as regards financial questions. Accountant-General. Director of Navy Contracts. (He is also under the Superintending Lords of the Department for which purchases are made.)	Finance.
	CIVIL LORD.	Director of Works. Accountant-General in regard to special questions affecting pay and allowances of the fleet. Director of Greenwich Hospital.	Works and civil personnel.
	CONTROLLER.	Director of Naval Construction. Director of Dockyards. Engineer-in-Chief, as regards *matériel.* Director of Naval Ordnance, as regards *matériel.* Director of Stores (except as regards coals for the fleet.) Expense Accounts Branch.	Matériel.
	JUNIOR SEA LORD.	Director of Transports. Director-General of Medical Department. Director of Victualing. Director of Stores, as regards coal for the fleet. Accountant-General, in regard to certain allowances, table money, etc. Chaplain of the Fleet, as regards chaplains and naval instructors. Intelligence Department, as regards matters connected with mobilization which affect above duties.	Personnel of the navy; movement, condition, and organization of fleet (including coaling, and maritime defense).
	SECOND SEA LORD.	Admiral Superintendent of Naval Reserves, as regards personnel. Engineer-in-Chief, as regards personnel. Chaplain of the Fleet, as regards naval schools. Manning the navy. Intelligence Department, as regards mobilization of the fleet.	
	FIRST SEA LORD.	Admiral Superintendent of Naval Reserves, as regards ships. Hydrographer. D. N. O., as regards G. and T. training establishments. Deputy Adjutant-General Royal Marines. Naval Intelligence Department. Discipline.	

The Permanent Secretary superintends all correspondence in the name of the Board, prevents the various departments acting independently, and provides for the due execution of orders.

NAVAL OFFICERS ATTACHED TO THE ADMIRALTY.

The composition of the Board of Admiralty has been given.

Office of Superintendent of Naval Reserves.—1 vice-admiral, admiral superintendent; 1 captain, assistant to same; 1 fleet paymaster, secretary; total, 3.

Hydrographic Department.—1 captain, Hydrographer; 1 captain, Assistant Hydrographer; 1 fleet paymaster, Chief Civil Assistant; 1 staff captain, 5 staff commanders, 2 lieutenants, naval assistants; 1 staff commander, Surveying Officer for Special Business; 1 staff commander, Superintendent of Compasses; 1 staff commander, Assistant Superintendent of Compasses; 1 staff captain, charge of chart branch; total, 15.

Naval Intelligence Department.—1 captain, Director; 2 captains, Assistant Directors; 5 commanders, naval staff; total, 8.

There is a marine staff composed of 1 major, 2 captains, and 1 lieutenant. A civil staff of 1 higher division clerk and 5 lower division clerks.

Royal Marine Office.—1 major-general, Deputy Adjutant-General; 1 colonel; 2 quartermasters (honorable majors); 1 major, Acting Deputy Judge-Advocate; total, 5.

Greenwich Hospital Department.—The Director is a civilian; 4 clerks and an accountant; 1 chaplain of fleet, Inspector of Schools; 1 captain R. Marines, Sub-inspector; total, 2.

Royal Observatory at Greenwich.—1 Astronomer Royal and 10 assistants.

Nautical Almanac Office.—1 superintendent and 11 assistants; all civilians.

DEPARTMENT OF CONTROLLER.

One rear-admiral, Controller; 1 captain, Director of naval Ordnance and Torpedoes; 1 captain, Assistant Director of Torpedoes; 1 captain, Inspector of Warlike Stores; 1 commander, Assistant to Director of Naval Ordnance; 2 commanders, Assistants to Director of Naval Ordnance; 2 lieutenants, Assistants to Director of Naval Ordnance; 4 gunners; total, 13.

Constructive Branch.—1 director of naval construction, Director; 2 chief constructors; 2 constructors; 16 assistant constructors, first, second, and third class; total, 21.

Engineering Branch.—1 engineer-in-chief; 1 chief inspector of machinery; 3 engineer inspectors; 2 chief engineers; 5 assistant engineers, first and second class; total, 12.

Dock-yard Branch.—A civilian, Director; 1 chief constructor; 1 constructor; 1 chief engineer; total, 3; and 3 civilians, Examiners.

Naval stores branch.—A civilian, Director; 3 civilians, Examiners of Store Accounts.

Controller's Accounts Branch.—3 civilians. There is a large clerical staff attached to the controller's department.

Department of Director of Transports.—1 captain, Director; 1 captain, Naval Assistant; 1 boatswain; total, 3; 1 captain, Indian navy, and a clerical staff.

Victualing Department.—A civilian, Director, very large clerical staff.

Department of the Accountant-General of the Navy.—Accountant-General in charge, a Deputy Accountant-General, 3 Assistant Accountant-Generals, and a large clerical staff. The department has no naval officers attached to it.

Contract and Purchase Department.—1 Director of Navy Contracts, 1 Assistant Director of Navy Contracts, a clerical staff; all civilians.

Department of the Medical Director-General of the Navy.—1 director-general, 1 deputy inspector-general, 1 staff surgeon; total, 3; clerical force.

Department of the Director of Engineering and Architectural Works.—The Director is a major-general, Royal Engineers. There are civilian surveyors, draughtsmen, etc.

One captain as Private Secretary to the First Lord.

A total of 89 officers of all corps.

Number of officers in each grade on the active list of the royal navy, 1890.

Admirals of the Fleet	3
Admirals	11
Vice-Admirals	20
Rear-Admirals	35
Captains	169
Commanders	224
Lieutenants	842
Sublieutenants	183
Midshipmen	325
Naval Cadets	33
Staff Captains	15
Staff Commanders	98
Navigating Lieutenants	11
Chief Gunners	21
Gunners	403
Chief Boatswains	21
Boatswains	366

Officers of Her Majesty's navy are divided into two branches. The above is the Military Branch. The Civil Branch is as follows:

Mechanical Engineers:	
Chief Inspectors of Machinery	5
Inspectors of Machinery	7
Fleet Engineers	55
Staff Engineers	80
Chief Engineers	115
Engineers	239
Assistant Engineers	194
Chaplain of the Fleet	1
Chaplains (including two Roman Catholic)	94
Naval Instructors	64
Royal Corps of Naval Constructors:	
Director of Naval Construction	1
Chief Constructors	3
Chief Constructors (dockyards)	9
Constructors	12
Assistant Constructors:	
First class	12
Second class	21
Third class	11

Medical Officers:	
Director-General of the Medical Department	1
Inspector-General of Hospitals and Fleets	4
Deputy Inspector-General of Hospitals and Fleets	12
Fleet Surgeons	57
Medical Officers—continued:	
Staff Surgeon	94
Surgeons	215
Paymasters:	
Fleet Paymasters	77
Staff Paymasters	56
Paymasters	66
Assistant Paymasters	164

RANK AND RELATIVE RANK.

[Extracts from naval regulations.]

The Military Branch, rank (and with the exceptions hereinafter mentioned, command also) in the following order:

1. Admirals of the Fleet.
2. Admirals.
3. Vice-Admirals.
4. Rear-Admirals.
5. Commodores.
6. Captains.
7. Staff Captains.
8. Commanders.
9. Staff Commanders.
10. Lieutenants.
11. Navigating Lieutenants.
12. Sublieutenants.
13. Navigating Sublieutenants.
14. Chief Gunners.
15. Chief Boatswains.
16. Gunners.
17. Boatswains.
18. Midshipmen.
19. Naval Cadets.

Commodores, when in the presence of captains senior to them, rank and command according to their seniority as captains.

When commanders, lieutenants, or sublieutenants, who are seniors to the Executive Officer, are appointed for navigating duties, they will, in the absence of the Captain, succeed to the command of the ship, but they are not to take upon themselves the routine duties of the Executive Officer, except by order of the Captain, or in case of necessity.

Staff captains, staff commanders, and navigating lieutenants, whatever their rank and seniority may be, are in all matters of command, and in all details relating to the duties of the fleet and to the discipline and interior economy of Her Majesty's ships, to be held subject to the authority of any officer not below the rank of lieutenant, who may be in charge of the executive duties of the ship, or in charge of any other special service or duty, of whatever seniority such officer may be.

Officers in command of Her Majesty's ships must, on occasions, whether on shore or afloat, take rank and precedence of officers placed under their command.

A ship must always be represented by an officer of the military branch in the following order of command:

1. Captain.
2. Commander.
3. Lieutenant.
4. Staff Captain.
5. Staff Commander.
6. Navigating Lieutenant.
7. Sublieutenant.
8. Navigating Sublieutenant.
9. Chief Gunner.
10. Chief Boatswain.
11. Gunner.
12. Boatswain.
13. Midshipmen.
14. Naval Cadet.

(*)

At courts of inquiry, surveys, and other similar assemblages of officers, the officer who in virtue of his office would, under these regulations, take the military command, is in all cases to preside, irrespective of the relative rank of the other members.

Officers who qualify for navigating duties will be required to perform those duties, if called on to do so, until promoted to the rank of captain.

They will be required to take a share in the ordinary duties of their ships, such as watch-keeping, and acting as divisional officers, as in the case of gunnery lieutenants. But this participation in the ordinary duties is not to interfere with their special navigating duties, and is to be arranged at the discretion of the captain.

All officers of the same denomination in the military branch shall rank and command according to the order in which their names stand in the official list of officers of the royal navy; or, when not inserted in the list, according to the dates of their first commissions, warrants, or orders, in their existing rank; and, if acting only, according to the seniority of their respective acting appointments; but commanders and lieutenants serving in a ship bearing the flag of a senior flag officer present, or the broad pendant of a commodore of the first class, being the senior officer present, or in the ship of the senior officer of five or more ships present, shall, when in the presence of, or acting under the immediate order from, such senior flag officer or commodore, or senior officer of five or more ships present, and detached on service in company with other commanders, and lieutenants of the fleet or squadron present, take rank and command respectively of all other commanders and lieutenants. Under all other circumstances, commanders and lieutenants of flag-ships, as well as those of other ships, will take rank only according to their proper seniority.

The Civil Branch shall consist of the undermentioned officers, and they shall rank in the following order, and with officers of the military branch, as herein expressed:

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[*] In foreign navies officers of the Civil Branches do not sit as members of courts-martial.

Denomination of Civil Officer.	To rank with—
1. Inspector-General of Hospitals and Fleets	Rear-Admiral, according to the date of commission.
2. Secretary to an Admiral of the Fleet	Captain of three years' seniority, according to the time served as Secretary to an Admiral of the Fleet.
3. Paymaster-in-Chief	Captain of three years' seniority, according to date of commission.
4. Chief Inspector of Machinery	Captain of three years' seniority, according to date of commission.
5. Deputy Inspector-General of Hospitals and Fleets.	Captain of three years' seniority, according to date of commission.
6. Inspector of Machinery of eight years' service.	Captain of three years whose seniority will reckon from the completion of such three years in that rank—that of the Inspector of Machinery from the completion of eight years' service as such.
7. Secretary to Commander-in-Chief, of five years' service as such.	Captain under three years' seniority. The Secretary to Commander-in-Chief is to reckon his seniority from the date of completing five years' service as such.
8. Inspector of Machinery, under eight years' service as such.	
9. Secretary to a Commander-in-Chief, under five years' service as such.	Commander, according to time served as such.
10. Fleet Surgeon	Commander. The Fleet Surgeon, Fleet Paymaster, and Fleet Engineer, according to date of commission. The Naval Instructor to reckon his seniority from date of completing fifteen years' seniority in his rank.
11. Fleet Paymaster	
12. Fleet Engineer	
13. Naval Instructor, of fifteen years' seniority.	
14. Secretary to a Junior Flag Officer, Commodore of first class, or Captain of the Fleet.	Lieutenant above eight years' seniority. The Staff Surgeon, Staff Paymaster, Staff Engineer, according to date of commission, the lieutenant and Naval Instructor to reckon their seniority from date of completing eight years' seniority in their respective ranks.
15. Staff Surgeon	
16. Staff Paymaster	
17. Naval Instructor, of eight years' and under fifteen years' seniority.	
18. Staff Engineer	
19. Paymaster	With, but after, Lieutenant of eight years' seniority.
20. Chief Engineer	
21. Secretary to a Commodore of second class.	Lieutenant under eight years' seniority, according to date of commission. The Assistant Paymaster and Engineer to reckon their seniority from the date of completing twelve and six years' seniority in their respective ranks.
22. Naval Instructor, under eight years' seniority.	
23. Surgeon	
24. Assistant Paymaster, of twelve years' seniority.	
25. Engineer, of six years' seniority	
26. Assistant Paymaster, of six and under twelve years' seniority.	With, but after, Lieutenant under eight years' seniority. The Assistant Paymaster to reckon his seniority from date of completing six years' seniority.
27. Engineer, under six years' seniority	
28. Assistant Paymaster, under six years' seniority.	With Sublieutenant, according to date of commission.
29. Assistant Engineer	
30 Chief Carpenter	With, but after, Sublieutenant. Naval Cadet according to date of entry.
31. Engineer Student	

Chaplains do not hold any naval rank.

All officers of the same denomination of the Civil Branch shall take rank of each other according to the order in which their names stand on the official list of officers; or, if acting only, according to the dates of their acting orders; or, when there is no list of any particular class, according to their length of service in Her Majesty's navy.

Officers of the Civil Branch are not to assume any military command whatsoever, either afloat or on shore; but, under the captain or other superior, they shall have all necessary authority within their own departments, and according to their relative rank, for the due performance of their respective duties, and they are to be obeyed accordingly by their subordinates.

Notwithstanding the relative rank and authority conferred by these regulations on officers of the civil branch, they are, in all such details and matters as relate to the service on which they are employed, the duties of the fleet, and to the discipline and interior economy of ships, to be subject to the authority of the officers of the military branch; and in no case shall they be deemed to be superior in rank to, or take precedence of, the officer appointed to command the ship or establishment in which they are employed, or the officer or other person on whom the command of such ship or establishment may properly devolve in the absence of the officer appointed to the command thereof.

If two officers of the civil branch are together and an officer of the military branch under whose command the senior of the two is serving, be also present, the junior officer of the civil branch, whatever his rank and standing may be, can not, in such case, take precendence of the officer of the military branch, but must assume his position, according to his rank and standing, after the officer of the civil branch next in rank or seniority above him.

GENERAL RULES—CONDITIONS OF RETIREMENT.

(1) *Admirals of the Fleet* to be retired at the age of 70. *Admirals* and *vice-admirals* to be retired at the age of 65 or at any age so soon as 10 years have elapsed since their flag was hauled down, or (if they have not hoisted their flag) since their service as captain ceased. *Rear-admirals* to be retired at the age of 60, or at any age so soon as 10 years have elapsed since their flag was hauled down, or (if they have not hoisted their flag) since their service as captain ceased.

To be retired irrespective of age at discretion of Admiralty if found physically unfit to serve.

(2) *Admirals* and *vice-admirals* to have the option of retiring at the age of 60, and rear-admirals at the age of 55.

Flag Officers who have not hoisted their flags as flag officers to be retired at the age of 60.

Until October, 1890, as a temporary measure, flag officers may retire at their option at the following ages, viz:

Admirals	55
Vice-admirals	55
Rear-admirals	50

Such optional retirement to be subject to Admiralty approval and to be restricted to three flag officers annually, power being reserved to the Admiralty to extend this option to a larger number hereafter should such course appear desirable.

Vice-admirals and rear-admirals retired from these ranks are entitled to rise by seniority, to the rank of retired admirals.

Captains.—(1) To be retired at the age of 55, or at any age if seven years have elapsed since they last served. (2) To have the option of retiring at the age of 50, and to be retired irrespective of age, at discretion of Admiralty, if found physically unfit to serve.

As in the case of flag officers six captains annually may retire at their option at the age of 45.

Captains who retire from that rank (unless retired on account of non-service) are allowed to rise to the rank of vice-admiral on the retired list, if, before retirement, they have served the time necessary to qualify a captain for promotion to rear-admiral on the active list.

Commanders (1) to be retired at the age of 50, or at any age if 5 years have elapsed since they last served; (2) to have the option of retiring at the age of 45, and to be retired, irrespective of age, at discretion of Admiralty if found physically unfit to serve.

Commanders retired from that rank may, by Admiralty permission, rise one step in rank if, before retirement, they had served the time to qualify them for promotion; if not so qualified for promotion, they may be allowed, at the discretion of the Admiralty, to assume the rank of retired captain on attaining 15 years' seniority, irrespective of qualifying service.

Lieutenants (1) to be retired at the age of 45, or at any age if 5 years have elapsed since they last served; (2) to have the option of retiring at the age of 40, and to be retired, irrespective of age, at discretion of Admiralty, if found physically unfit to serve.

Lieutenants retired from that rank may, by permission of the Admiralty, rise one step in rank, if, before retirement, they have served the time to qualify them for promotion on the active list; but no officer can obtain this step till he has attained the age.

Sublieutenants to be compulsorily retired at the age of 40, or at any age if found physically unfit to serve.

Retirement of Navigating and Civil Officers.

Rank.	Age.		Optional, may retire.
	Compulsory.	At any age if have not served as follows.	
	Years.	*Years.*	*Years.*
Staff Captains	60	7	....
Staff Commanders	55	5	....
Navigating Lieutenants	45	5	....
Inspectors and Chief Inspectors of Machinery	60	7	55
Chief, Staff, and Fleet Engineers	55	5	50
Engineers	45	5	....
Assistant Engineers	40	5	......
Chaplains of the Fleet	60	....	....
Chaplains	60	5	....
Naval Instructors	60	3	55
Inspectors and Deputy Inspectors-General of Hospitals and Fleets	60	5	....
Fleet Surgeons	55	5	....
Staff Surgeons	55	5	....
Surgeons	55	5	....
Fleet Paymasters	60	5	55
Staff Paymasters	60	5	55
Paymasters	60	5	55

An officer may be placed on the retired list of his rank if (1) he is guilty of such repeated acts of misconduct or neglect of duty as in the opinion of the Admiralty make him unfit for further active service; (2) he is in the opinion of the Admiralty, after careful inquiry, unfit for further active service through intemperate or irregular conduct or habits.

Retirement from the active list is not to disqualify any officer for employment at or under the Admiralty.

QUALIFICATIONS AND PROMOTION.

The service required by flag officers, captains, commanders, lieutenants,, and other officers for promotion is regulated by the definitions of sea and harbor service.

Admirals of the Fleet will be selected by Her Majesty from the Admirals on the active list who have served as Commanders-in-Chief or who have commanded at sea as Flag Officer for 2 years.

Vice-Admirals will rise to the rank and title of Admiral on the active list according to seniority.

Rear-Admirals will rise to the rank and title of Vice-Admiral on the active list according to seniority, but Flag Officers who have not hoisted their flags as Flag Officer, will be retired at the age of 60.

To qualify a Captain whose seniority brings him in turn for advancement to the active list of Flag Officers, he must have completed 6 years' service as Captain, the first 3 years of such service must be sea service in command of a ship of war at sea; or he must, whether he elected the old or the new regulations, have completed 4 years on the books of one or more of Her Majesty's ships as Captain during war, or 5 years of such service during war and peace combined; 3 years of such service in either case to be sea service in command.

Captains who arrive at their turn for promotion without having completed the qualifying service to be retired.

The promotion of Flag Officers and Captains, when vacancies take place or when additions are made to the Flag Officers' list, are also regulated by seniority. As vacancies occur on the active list, the Captain first in seniority who has served his time for his flag will be promoted, but Her Majesty's undoubted right of selection is reserved.

In the event of a Captain, whose seniority brings him in turn for advancement to the rank of Flag Officer, preferring to continue as a Captain, he may be placed on a retired list of captains.

No Captain who shall have declined service when called upon, or against whose character there may be anything affecting him as an officer and a gentleman, shall be considered eligible for advancement to the rank of Flag Officer.

To qualify a Commander for promotion to the rank of Captain on the active list, he must have completed 2 years' sea service as Commander, or its equivalent in harbor service, but 1 year of such period must be sea service in a ship of war at sea.

A Commander may be promoted to the rank of Captain for gallantry in action, provided he has completed 1 year's sea service or its equivalent in the rank of Commander.

No Commander is eligible to command a stationary ship at home who has not had 1 year's sea service in a ship of war at sea.

To qualify a Lieutenant for promotion to the rank of Commander on the active list, he must have completed 4 years' sea service as Lieutenant or its equivalent in harbor service, but 3 years of such period must be sea service in a ship of war at sea, or gunnery or torpedo staff time.

A Lieutenant may be promoted to the rank of Commander for gallantry in action, provided he has completed 2 years' sea service or its equivalent in the rank of Lieutenant.

To qualify a Midshipman passed into Britannia prior to November, 1889, for the rank of Lieutenant, he must have attained the age of 19 years, and have completed 5 years' service in the royal navy, including the time awarded to him on leaving the training ship. For that of Sublieutenant, he must have served the time and be qualified for the rank of Lieutenant.

Midshipmen passed into Britannia in November, 1887, or June, 1888, will be qualified as above, except they must have completed 4 years 9 months of requisite service, and those who passed into the Britannia in or after November, 1888, must have completed 4 years 6 months of requisite service.

To qualify a Naval Cadet for the rank of Midshipman, he shall have served so much time as, with the time allowed him in the training ship, will make up 1 year, and shall pass the required examination.

To qualify a candidate for Naval Cadet, he shall when first examined be of the age required, and shall pass such examination as the Admiralty may from time to time direct.

To qualify a Staff Commander for the rank of Staff Captain, he must receive an appointment as Staff Captain or Assistant Staff Captain of a dock-yard or as Queen's harbor-master, or he must have completed 15 years' sea service as a commissioned navigating officer and have performed such special services as in the opinion of the Admiralty render him deserving of promotion.

To qualify a Navigating Lieutenant for the rank of Staff Commander, he must have passed for first-class ships for pilotage, and have 10 years' service as a Navigating Lieutenant, or be of 15 years' seniority in that rank, with 7 years' service, in either case he must have 5 years' sea service in a ship of war at sea.

Advancement to the rank of Staff Commander is at the discretion of the Admiralty, and will only be bestowed upon officers of good character and qualifications.

Navigating Lieutenants are eligible for promotion to the rank of Staff Commander for distinguished or highly meritorious service, provided they have completed two years' sea service as Navigating Lieutenants. Should, however, an officer so selected not have passed for first-class ships for pilotage, he is only to be promoted to the rank of Acting Staff Commander, but he will be confirmed with his original seniority, provided he pass within a reasonable time of his arrival in England. In such a case the regulation that an officer must serve 3 years before he can pass will be dispensed with.

Navigating Lieutenants and Staff Commanders may, for distinguished war service, be transferred to the lists of Lieutenants and Commanders respectively, taking with them their seniority and the benefit of any higher full and half pay until promoted to a superior rank. Navigating Officers of those ranks may also, at the discretion of the Admiralty, in very deserving cases, be promoted direct to the rank of Lieutenant, Commander, or Captain, respectively, but such promotions are not to exceed 3 a year.

The qualifications for the office of Chaplain are that the candidate shall have been ordained deacon and priest of the Church of England, or have been admitted to the same holy orders by the lawful authority of one of the churches within the realm of Great Britain and Ireland which are in communion with the Church of England; that his age does not exceed 35 years; that he holds no benefice with a Cure of Souls. He must produce testimonials from the Bishop of the Diocese in which he was last licensed, addressed to the Admiralty, and must have been examined by some competent person appointed for that purpose by the Admiralty, who shall have reported him to be in every respect a fit and proper person to fill the office of Chaplain with respectability and advantage to Her Majesty's service.

Clergymen in priests' orders will be allowed to take temporary service in the navy, without any restrictions as to age, and will be appointed Acting Chaplains for temporary service. While so employed they will occupy the same position, enjoy the same privileges, and be subject to the same regulations as ordinary chaplains; but they will not be entitled to half-pay or any other advantages at the termination of their temporary service.

An officer to be qualified for a commission—as *Inspector-General of Hospitals and Fleets*—must have served 5 years as Deputy Inspector-General, or three years in charge of a foreign hospital, or of a fleet or squadron.*

The rank of Fleet Surgeon will be granted to Staff Surgeons on completion of 20 years' full-pay service, if recommended for advancement by the Medical Director-General, and subject to approval of the Admiralty. Special promotions from the rank of Staff Surgeon to that of Fleet Surgeon are made a discretion of the Admiralty in cases of distinguished service or conspicuous professional merit, and will not exceed the rate of one such promotion in 2 years, and the whole number at any one time of Fleet Surgeons holding that rank by such promotions is not to exceed six. A Staff Surgeon specially promoted to that rank will be eligible, if recommended by the Medical Director-General for promotion to the rank of Fleet Surgeon, after 8 years full-pay service.

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* Or, four years mixed service, of which not less than two have been abroad.

Rank as Staff Surgeon will be granted, subject to approval of Admiralty, to Surgeons at the expiration of 12 years from the date of entry, provided they are recommended by the Medical Director-General and have passed such examination as may be required after completion of 8 years from date of entry in the rank of surgeon.

Special promotion to the rank of Staff Surgeon will be made at the discretion of the Admiralty in cases of distinguished service or conspicuous professional merit. Such promotions will be exceptions, and not exceed the rate of one a year. The total number at any one time of Staff Surgeons holding that rank by such special promotions will not exceed eight. No officer will be so promoted unless he passes the examination prescribed for other Surgeons, but in such a case the requirement of 8 years' time in rank of Surgeon will be dispensed with.

A candidate for entry to Surgeon must not be under 21 nor over 28 years of age; he must be registered as licensed to practice medicine and surgery in Great Britain or Ireland and pass such examinations and produce such other proofs of his qualifications as the Admiralty may from time to time require; his seniority on entry will be determined by the order of merit in which he passes the competitive examination in London.

To qualify an officer to receive a commission as *Secretary to a Flag Officer* or Commodore of the first class, he must be on the list of Secretaries or Paymasters.

To qualify an officer to receive a commission as Secretary to a Commodore of the second class he must be on the list of Secretaries, Paymasters, or Assistant Paymasters.

On completing 8 years' service in the rank of Secretary to Flag Officers or Commodores of the first class, the officer will be placed on the permanent list of Secretaries.

To qualify an officer for the retired rank of *Paymaster-in-Chief*, he must have 20 years' service as Secretary, or Paymaster, or Acting Paymaster.

The qualifications for *Paymaster* are 3 complete years' service as clerk to a Secretary to a Flag Officer, or as a clerk in the navy, or in those capacities combined. He must be 21 years of age, and have passed the required examination.

An Assistant Paymaster must be qualified for Paymaster.

To qualify an Assistant Clerk for Clerk, the candidate must have served one year as Assistant Clerk in one or more ships; he must not be under 17 years of age, and must have passed such examinations as the Admiralty may from time to time direct.

To qualify a candidate for Assistant Clerk, he must not be under 15 or over 17 years of age, and must pass the required competitive examination, and he must be able to swim.

QUALIFICATIONS REQUIRED FOR ENGINEER OFFICERS.

For Chief Inspector of Machinery, long and meritorious service.

For Inspector of Machinery, service as Fleet, Staff, or Chief Engineer of one or more ships on full pay for 5 years, including 2 years' service in sea-going ships as Fleet, Staff, or Chief Engineer in charge of engines.

For Fleet Engineer, 8 years seniority as Staff and Chief Engineer.

For Staff Engineer, 4 years seniority as Chief Engineer.

For Chief Engineer, service as Engineer in one or more ships in commission, or in Reserve for 3 years and to have passed the required examination.

For Engineer, may pass after 3 years' service as Assistant Engineer and to be eligible for promotion after 5 years' service.

Probationary Assistant Engineers will be appointed from the Engineer Students on the completion of their training on passing the examination, and such of them as the Admiralty may see fit will be allowed to join the Royal Naval College for further instruction. They will be confirmed at the end of their 12 months' probationary term if their qualifications and conduct are reported satisfactory, and those who obtain first-class certificates will count their 12 months' probationary time toward promotion; second-class certificates, 6 months' probationary time toward promotion; third-class certificates, 3 months probationary time toward promotion; provided they also pass very creditably in professional subjects, knowledge of engine-room duties, and practical workmanship. To qualify a candidate for *Engineer Student* he must be of the required age when first examined.

Two Acting or Probationary Engineers will be selected from those who take the highest place at the examination on the completion of their term at Greenwich, to pass through a further course of scientific instruction if they desire it.

They will be examined at the end of the second term, and will, at the discretion of the Admiralty, be allowed to remain a third term at Greenwich, on the completion of which they will be sent to sea as Assistant Engineers, and after 1 year's service at sea, they will be considered eligible to fill positions in the dock-yards and at the Admiralty.

Those passing the second and third term at the Royal Naval College at Greenwich will be attached during the vacations between June 30 and October 1, to the dock-yards or steam reserves, where they will attend trials of new and repaired engines, and otherwise be afforded opportunities and gaining experience of the duties they will have to perform at sea.

An Assistant Engineer who is selected at the end of the first session of the Royal Naval College to remain for two more sessions at the college will be required to enter into a bond with surety for the sum of £500 not to leave Her Majesty's service within 7 years of the completion of the term at Greenwich. This is in reference to defraying the charges incurred by the public for his education.

Resignation is in every case to be subject to the approval of the Admiralty.

Proportion of officers in each grade to number of ships.

1 admiral of the fleet to 122 ships.

1 flag officer to 5–6 ships.

1 commanding officer to every ship and a surplus of 28, not including staff captains and staff-commanders, of whom there are 113.

2 lieutenants (including navigating lieutenants) to every ship and a surplus of 123.

1 sub-lieutenant to every 2 ships.

1 midshipman to every ship, including cadets.

1 to 2 engineers to a ship.

1 surgeon or medical officer to a ship and a surplus of 18.

1 paymaster to each ship.

FRANCE.

The French navy is represented in the cabinet by a minister bearing the title of "*Ministre de la Marine.*" The present incumbent is a civilian, a senator, although the office has frequently been held by a vice-admiral. The Minister is entirely responsible for the efficiency of the navy. The organization provides for the administrative and executive duties of the department being distinct. The former provides the personnel and material, the latter manipulates it during peace and war. The executive functions are carried out by the Cabinet of the Minister and the General Staff. The Chief of the General Staff is the immediate assistant of the minister. The administrative duties are carried out by Departments or Directions. The Chief of the General Staff and one other officer of the staff are specially attached to the minister; the rest of the staff form a permanent personnel, which does not change with the Minister of Marine. The ministry is divided into three distinct orders of service: "*Administration Centrale*," "*Inspection Générale*," and "*Institution Consultative*." The Central Administration comprises the Minister's Cabinet, four Directions, the Establishment of the Invalids, and the Central Control. The chiefs of the four Directions and of the Establishment of the Invalids are selected by the Minister. Each Direction is charged with a special branch and is subdivided into offices with more or less reponsibility.

ADMINISTRATION CENTRALE.

The Minister's Cabinet is at present under the direction of a rear admiral, the Chief of General Staff, and is divided into two offices, the first of which manages the correspondence, centralizes the work with the President of the Republic, and that concerning several Directions, has charge of the relations of the department with the national assembly and the council of state, the centralization of work connected with the Legion of Honor, etc., and the second office is charged with the movements of the fleet and military operations, fitting out, putting out of commission, and service of the reserve, transport of *personnel* and *matériel*, instructions to General Inspectors, Commanders of Naval Forces, and to officers sent on special missions by the Minister, etc. The second office is in charge of a captain in the navy. With this exception and that of the Director, the force is civilian.

First Direction—Personnel: Has charge of the recruiting, education, organization, discipline, maintenance, and movements of all the various classes of the personnel of the marine. The department is presided over by a *capitaine de vaisseau*, with a captain as *adjoint* to the Director. There are six offices or sections.

First section: Corps of officers of the fleet.

Second section: Ships' companies, the reserves; maritime inscription and conscription.

Third section: Troops, artillery and infantry; companies of workmen and artificers (officers and men both in France and the colonies).

Fourth section: *Corps entretenus*, Civil officials, and agents of various kinds; maritime justice.

Fifth section: Pay, clothing, and surveys.

Sixth section: Subsistence and hospitals.

A *capitaine de vaisseau* is in charge of first section, a *capitaine de frégate* of the second section, a colonel of marine infantry of the third section. Civilians are in charge of the fourth, fifth, and sixth sections. There is a large clerical force of civilians attached to the Direction, but no other officers than those mentioned.

Second Direction—Matériel: A Director of Naval Construction in charge. An engineer of first class of the corps of naval constructors as Subdirector. This department is charged with the creation and maintenance of the material of the fleet and arsenals, and is divided into four bureaus or sections.

First section: Engineer of second class of the corps of naval constructors, being the Chief, is charged with naval constructions; presents plans and estimates for ships, engines, and all other naval material, except as mentioned hereafter; the construction and maintenance of the same; allowances for the equipment of the fleet; has charge of tools, plants, workshops, and manufactories; employment and pay of workmen; direction of the lithographic printing office of the Ministry of the Marine; preparation of the list of the fleet, etc.

Second section: Hydraulic works and civil buildings; construction and maintenance of same, and of the roads, and care of real estate belonging to the navy. Chief, a civilian.

Third bureau: [Likely to be separated from this Direction], Artillery (ordnance, except torpedoes); construction of all ordnance material for the fleet, arsenal, forts, and batteries, where the defense is confided to the navy, whether the material is made in naval or private establishments; contracts, purchase, care, and repair of same. Chief, a colonel of naval artillery.

Fourth section: General stores, freight, and transport. A paymaster in charge (*commissaire-adjoint*). Contracts for all material other than mentioned above; freight and transportation of same, and care, preservation, and arrangement in the store-houses. A director of naval construction and a colonel of artillery superintend work entrusted to private establishments, and a chief engineer (*mécanicien en chef*) inspects fuel.

Third Direction.—Direction general of torpedoes: Torpedo defense of littoral. Command of the *personnel* attached to the service. Furnishing and manufacture of torpedo material; experiments and manœuvres, plans of combat, etc. Rear-admiral in charge. A captain and a lieutenant are attached to the department.

Fourth Direction.—Accounts (*Comptabilité Générale*): This department is in charge of the Senior Paymaster-General of the navy. He is also a member of the Council of State. A civilian is Subdirector. There are six bureaux, all presided over by civilians. In general, the duties of this department are those of treasurer and accountant.

First bureau: Funds, *Ordonnances*, and expenses abroad.

Second bureau: Central accounts (*comptabilité centrale*) of funds and pensions. Estimates.

Third bureau: Accounts concerning *matériel.*

Fourth bureau: Interior service; personnel of Central Administration; printing.

Fifth bureau: Archives, libraries, and publications.

Sixth bureau: Commercial navigation, fisheries, and maritime occupations ("domanialité maritime").

The Directions of *Personnel* and of *Matériel* submit items of the budget relating to their departments, but it is the duty of the Direction of General Accounts to prepare the budget in full, including estimates of cost. This Direction receives and dispenses the credits under the Minister and according to the acts of law, and centralizes accounts. It represents at the navy department the same unity and order of accounts as does the Paymaster-General at an arsenal where he is the sole director of expenses and the centralizer of accounts.

There is an accounting agent of the ministry—a civilian—who disburses the money placed at the disposition of the Minister, pays the salaries of attendants, etc., at the department.

L'Etablissments des Invalides de la Marine is also attached to the Central Administration, and is in charge of a civilian as Administrator. This department is divided into two bureaus and a treasury; has charge of and disburses the pension fund, keeps pension accounts, etc. Part of the fund is derived from deductions made from the pay of those in the navy and others, part from gifts and legacies, and part by appropriation.

The *Contrôle Central* has a *personnel* composed of civilians called Inspectors, one of whom is Inspector-in-Chief. Their duties are in connection with the administrative and financial services of the marine, and they examine all propositions submitted to the Minister by the Directors on the subject of financial matters, purchases, contracts, and other engagements. They also examine the current accounts of the funds kept at the *Comptabilité Centrale* and control the operations of the *Etablissement des invalides.*

INSPECTIONS GÉNÉRALES.

There are five permanent *Inspections Générales:*

First. Of artillery of the navy and colonies: One general of division, Inspector-General; two generals of brigade, Assistant Inspectors General.

Second. Of infantry of the navy: One general of division, Inspector-General; one general of division, and three generals of brigade, Assistant Inspectors General.

Third. *Génie maritime* (naval construction): One Inspector-General of the corps, *génie maritime*; one Director of Naval Construction, assistant.

Fourth. Of maritime works: One Inspector-General of second class, of Roads and Bridges is charged with the general inspection, and one Engineer-in-Chief of Roads and Bridges as assistant.

Fifth. Of maritime fisheries: One Inspector-General (civilian).

Whenever the Minister judges it necessary the Inspectors visit the naval ports or establishments to ascertain the manner in which the work which concerns them is carried on. Their technical reports are often the cause of improvements, with the development of which the central administration is charged. Between the dates of these periodical inspections the Inspectors occupy themselves with technical studies confided to them by the Minister and take the initiative in all subjects pertaining to their specialty.

A Flag Officer is charged by the Minister with the inspection of ship's companies.

The General Staff of the Minister *État-Major Général du Ministre* is composed of the Chief of the General Staff and Director of the Cabinet [a rear admiral], a captain as Sub-chief, and sixteen officers of the Military Branch of the navy, artillery, and infantry of the marine. There are three sections, among which the work is distributed as follows:

First section has study of maritime forces and the defense of the coasts of foreign powers, and the collection, care, and arrangement of the documents relating to these subjects. A commander is Chief of Section, and a commander is Archivist. There are 4 *lieutenants de vaisseau*, 1 captain marine artillery, and 1 captain marine infantry, all *officiers d'ordonnance* attached to the section.

Second section: Defense of military ports and of the coasts of France and Algiers and mobilization of the troops of the marine. Its personnel consists of 1 commander as Chief, 1 lieutenant-colonel of marine infantry, 1 *lieutenant de vaisseau*, *officier d'ordonnance*, and 1 captain of infantry (army).

Third section: Preparation of naval and military operations. Mobilization of the fleet. The Sub-chief of the General Staff, a *capitaine de vaisseau* is in charge. He has for assistants three *lieutenants de vaisseau*, *officiers d'ordonnance.*

Private Secretariat of the Minister.—Chief, a *commissaire de la marine* (paymaster).

Hydrographic Service.—1 Hydrographic Engineer in Chief, member of the institute; 1 Hydrographic Engineer, first class, chief of service of general hydrography; 1 Hydrographic Engineer, first class, chief of the service of the coast of France; 1 Hydrographic Engineer, first class, chief of department of charts and archives; 1 Commander, *chef du service des Instructions nautiques*; 1 Hydrographic Engineer, first class, chief of the department of scientific instruments; 1 Commander, chief of department of nautical instruments (general stores); 1 lieutenant, chief of nautical meteorological service.

The duties of this office are, general direction of the works of the hydrographic service; execution and superintendence of work of every nature connected with the hydrographic service; care, preservation, and classing of charts, plans, and drawings, and documents of all kinds which form the scientific archives. There is also an agent of administration, with an under chief (*sous chef*), assistant, and seven clerks, who prepare contracts, verify and record invoices, etc., and in general all administrative operations to which the hydrographic service can give rise, superintend the book-keeping and accounts of the material in the store-houses of the establishment. There is also a store-keeper accountant, who is in charge of and responsible for all objects in the store-houses. Also, a librarian, who has the care, preservation, and classification of the books under the authority of the hydrographic engineer in chief.

INSTITUTIONS CONSULTATIVE.

This service is composed of councils, committees and permanent commissions with fundamental functions, and was established for the purpose of aiding the Minister by advising him. The principal one of these councils has been, and to a certain extent still is,

The *Admiralty Council*, which is consulted by the Minister upon all questions touching the organization of the service, and the legislation of interests of which the Department has charge, and except in cases of urgency no project of law will be presented (except the budget and accounts) no measure of organization will be converted into law or regulation without the previous advice of this Council. The projects will be preceded by the words "*le conseil d'amirauté entendu.*" The minister is not bound by the findings of the Council.

The members are appointed for three years, and may be reappointed.

To assist the Council in forming their conclusions, the Directors of the Ministry (*Administration Centrale*) and the Inspectors-General are called upon in matters concerning their offices, and they have a deliberative voice at the sittings. The Council is also charged with the promotion, by selection, of officers. It is composed of the Minister of Marine as president, 4 vice-admirals (the senior of whom is vice-president), 2 rear-admirals, 1 brigadier-general of marine artillery, the Senior Director of Naval Construction, 1 paymaster-general, and 2 captains of the navy, *membres adjoint*, and 1 paymaster, secretary.

By Presidential decree of December 5, 1889, a Superior Council was created, to which some of the former functions of the Admiralty Council have been assigned. From the organization, etc., of the Admiralty Council the minister did not consider the conditions favorable for its furnishing indisputable advice on certain questions; advice which he considered necessary to give his decisions an indispensable force and authority, and which should be above dispute, and this he stated in his letter to the President, asking for the creation of a new council.

The *Superior Naval Council* is charged with the examination of questions connected with the preparation for maritime war, and is necessarily consulted by the Minister on the essential arrangements for the mobilization of the fleet, and on the principles which should govern the renewal of the fleet and its distribution; and, in general, on all questions affecting the best use and preparation of the naval army for the defense of the country. The Council meets on the call of the Minister as often as the needs of the service require, and must meet at least twice each year, and keep a journal or minutes of its proceedings. Questions submitted to the Council are communicated individually to the members at least three days before the meeting, and unfinished business of one meeting is taken up at a subsequent meeting.

The Council is composed of nine members, as follows: The Minister of Marine, President; the Vice-President of the Admiralty council, who is a vice-admiral; the President of the Council of Works, who is a vice-admiral; Vice-Admiral, *Commandant-en-Chef D'Escadre;* two *Prefets Maritimes*, appointed by the Minister; the general, Inspector-General of Marine Artillery, Inspector-General of Maritime Engineers (*génie maritime*), the Chief of the General Staff of the Ministry.

The Chiefs of Section of the General Staff are attached as secretaries, with a consultative voice.

Directors of the various services of the ministry and general officers, or high functionaries, may be admitted to the Council for the discussion of affairs of their departments.

In case of the absence of the Minister the precedence devolves always on the senior vice-admiral member of the Council.

Council of Works.—1 vice-admiral, president; 1 vice-admiral; 1 general of brigade of shore artillery; 2 rear-admirals; 1 civilian; 1 general of division, marine artillery; 1 general of brigade, marine artillery; 1 inspector-general of maritime engineering (*génie maritime*); 1 inspector-general, second class, bridges and roads; 1 director of naval construction; 3 captains (navy); 1 colonel of marine artillery; 2 first-class naval engineers (*génie maritime*); 1 engineer-in-chief of bridges and roads, members; 1 sub-engineer of first class (*génie maritime*) secretary.

Charged with preparatory examination of plans, estimates, and detail projects relative to work of every class to be executed at the arsenals.

Council divided into five sections for expedition of work: (1) Nautical questions. (2) Construction of ships and machinery. (3) Ordnance. (4) Hydraulic works. (5) Submarine defenses.

General officers appointed for three years. Others for two years.

Hydrographic Committee.—Rear-admiral, president; Hydrographic Engineer-in-Chief; 1 *capitaine de vaisseau;* 1 hydrographic engineer, first class, commander; 1 hydrographic engineer, second class, members, and one hydrographic sub-engineer, second class, secretary.

The Committee for the Examination of the Accounts of Marine Works (*trauvaux de la marine*) is composed of eleven members, five civilians and the President of the Council of Works, and three other members of that council and the Inspector-in-Chief of the *Contrôle Central* and the Commissary General, member of the Board of Admiralty, and a *Commissaire* as secretary.

Permanent Commission of Control and Revision of Rules of Equipment and Uniform (Armement et Habillement).—1 rear admiral; 1 captain; 1 lieutenant-colonel, marine artillery; 1 inspector of the services *Administratif et Financiers* (navy); 2 commanders; 1 engineer, first class (*géne maritime*); 1 naval surgeon-in-chief (*medecin en chef*).

Charged with the study of the condition of equipment for each new type of ship, effective complement of officers and crew; an inventory and table of consumable materials to be allowed ships, etc. A permanent committee to take charge of these matters was considered necessary on account of the many different types of vessels, etc.

Permanent Commission of Purchases.—Paymaster-General of the navy, president; 1 captain; 1 commander; 1 lieutenant-colonel of artillery (marine); engineer of first class (*génie maritime*); 2 officials of the central magazine, of which one is secretary of commission.

Contracts not coming under the other commissions.

Permanent Commission of Machinery and Plant (grand outillage).—1 inspector of maritine engineers (*génie maritime*), president; 2 directors of naval construction; 1 paymaster-general; 1 captain; 2 colonels of marine artillery; 1 naval engineer, first class (*génie maritime*); 1 assistant paymaster, secretary.

Purchase of vessels, engines, large tools, and of artillery (ordnance).

Permanent Commission of Libraries of the Ship's Companies, of Naval Troops, and Maritime Prisons.—One vice-admiral, 1 colonel marine infantry, 1 chief of bureau at the ministry of public instruction, 1 captain, 1 colonel of marine artillery, 1 commander, 1 librarian to the ministry, 1 secretary.

Establish and modify catalogues of books furnished to libraries, etc.

Superior Commission of Archives of the Navy.—Of the 21 members there are 3 naval officers (2 vice-admirals and 1 naval constructor, retired).

Commission of Light-Houses.—Minister of Public Works, president, 1 vice-admiral, vice-president, 6 inspectors-general of roads and bridges, 1 inspector-general of naval construction, 2 rear-admirals, a member of the Academy of Sciences, 1 hydrographic engineer in chief, 1 engineer in chief of roads and bridges, secretary.

Advise on all questions relating to the lighting and buoying of the littoral, etc.

Consultative Committee of the Law Business of the Navy.—Eleven members, all civilians, taken from the council of state, the bar, the court of accounts, and render opinions on all questions of law submitted to them by the Minister.

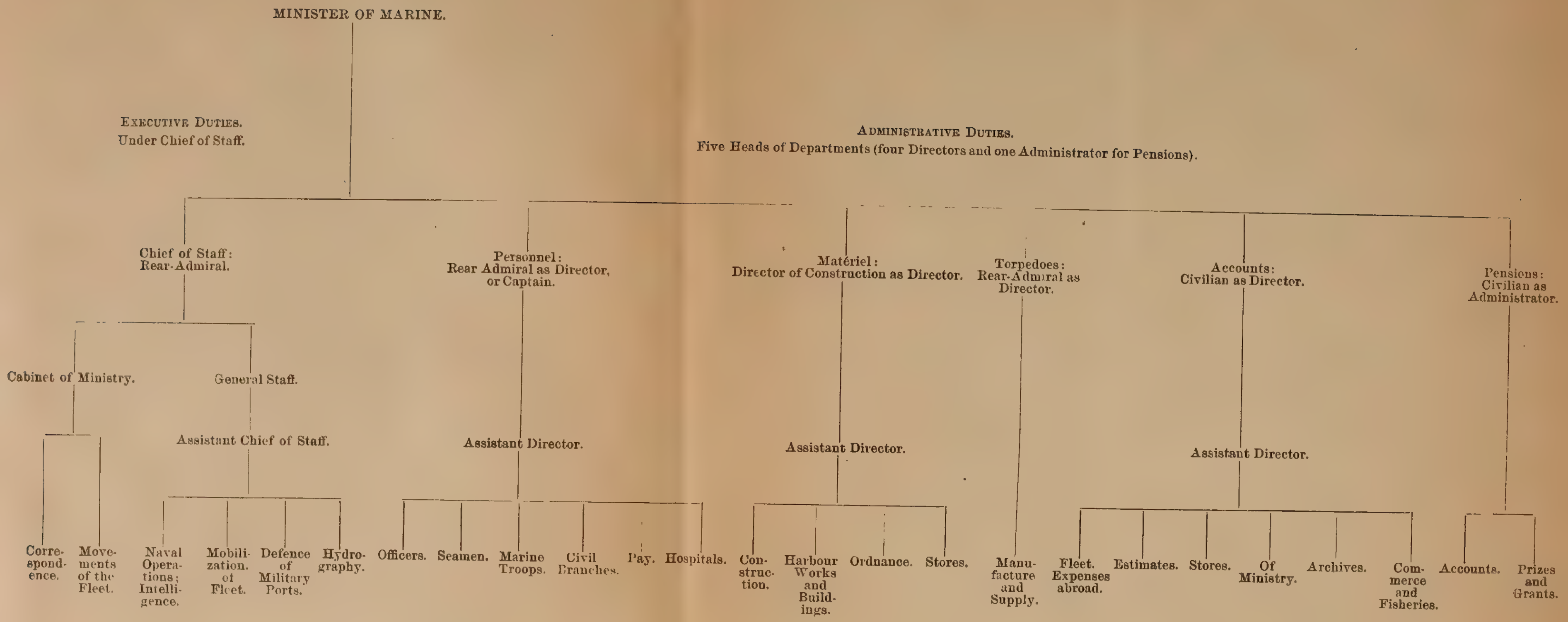
Consultative Committee on Fisheries.—Fourteen members of whom one is the Paymaster-General of the Navy and one a captain. The others are civilians.

Technical Committee of the Inspectors-General of the Marine Troops.—Three major-generals and 5 brigadier-generals of the marine, artillery, and infantry, charged with study of questions of mobilization, instruction, and organization of troops.

Committee of Defense.—Composed of, The President of the Republic, president, Minister of War, vice-president; Members of Superior Council of War, the President of Consultative Committees of Artillery (ordnance), of Fortifications and of *Intendance*. The Directors of Artillery and of Engineering of army, Chief of Staff of the Ministry of Marine, the Commander of the Army Corps, and the Inspectors-General, artillery and engineering, of the arrondissements in the territories in which are located the defenses to be organized or modified. The President of the Board of Admiralty (a vice-admiral), the Major-General, Inspector-General of artillery (naval), and the Préfet of the Maritime District interested. The naval members examine questions concerning the organization of the defense of the coasts or that part of the country confided to the marine.

Superior Sanitary Council.—One Director of the Sanitary Service, president, 1 chemist or dispenser in chief, 2 surgeons-in-chief (*medecen in chef*), members, 1 principal surgeon, secretary.

Consulted on questions of naval hygiene, on hospital construction, barracks, and prisons, etc. On hospital organization, ashore and afloat, receive all communications on medical affairs (requests for sick-leave, medical reports, etc.), and make propositions concerning them, etc.



CONSULTATIVE.

1. Admiralty Council.
2. Council of Works.
3. Commission on Equipment.
4. Commission on Machinery.
5. Inspector-General of Artillery, Infantry, Construction, and Works.
6. Superior Council.

MILITARY BRANCH.		CIVIL BRANCH.											
Officers.		Officiers, Mécaniciens (mechanical engineers).		Corps du Génie Maritime (naval constructors).		Ingénieures Hydrographe (hydrographic engineers).		Corps du Comissariat (paymasters).		Corps de Santé (medical officers).		Corps de L'inspection (inspectors)	
15	Vice-Admiraux (vice-admirals).												
30	Contre Admiraux (rear-admirals).			1	Inspecteur-Général.								
				11	Directeurs des Constructions Navales, assimilation; after rear-admirals, ahead of captains.	1	Ingénieur en chef.	7	Commissaires-Généraux, de 1re classe et 2e classe (paymasters-general).	6	Directeurs.	7	Inspecteurs-en-Chef (de 1re et de 2e classe).
105	Capitaines de Vaisseau (captains).	2	Mécaniciens Inspecteurs (inspectors).	23	Ingénieurs de 1re classe.	3	Ingénieurs, de 1re classe.	27	Commissaires (paymasters).	19	Médecins-en-Chef (Surgeons).	17	Inspecteurs.
										6	Pharmacien-en-Chef (pharmacists).		
208	Capitaines de Frégate (commanders).			20	Ingénieurs, de 2e classe.	4	Ingénieurs, de 2e classe.						
	Capitaines de Corvette (lieutenant-commanders).	9	Mécaniciens-en-Chef (mechanical engineers-in-chief).					49	Commissaires-Adjoint (paymasters).	64	Médecins Principaux.	8	Inspecteurs-Adjoint.
										9	Pharmaciens Principaux.		
98	Lieutenants de Vaisseau (lieutenants).	62	Mécaniciens Principaux, de 1re classe.	52	Sous-Ingénieurs, de 1re classe et de 2e classe.	6	Sous-Ingénieurs, de 1re classe et de 2e classe.	179	Sous-Commissaires (assistant paymasters).	226	Médecins, de 1re classe.		
										18	Pharmaciens, de 1re classe.		
421	Enseignes de Vaisseau (sub-lieutenants).	78	Mécaniciens Principaux, de 2e classe.	24	Sous-Ingenieurs, de 3e classe.			114	Aides-Commissaires (assistant paymasters).				
						2	Sous-Ingénieurs, de 3e classe.			229	Médecins, de 2e classe.		
										48	Pharmaciens, de 2e classe.		
226	Aspirants, de 1re classe (midshipmen, first class).			10	Élèves.			20	Éléves-Commissaires (students).	5	Aides-Médecins.		
							Éléves.			2	Aides-Pharmaciens.		
86	Aspirants de 2e classe (midshipmen, second class).								(Pay agents of all classes from Agent Principaux to Sous-Agents).				

In addition to the above there are 15 ingénieurs des ponts et chaussées (civil engineers) and 23 chaplains.

LAWS OF PROMOTION AND RETIREMENT.

French naval officers are recruited from four different sources:

(1) Naval school at Brest.

(2) Polytechnic school (four each year).

(3) By nomination to rank of *Enseigne* of first masters (*Premiers maî-tres*) who pass a certain examination.

(4) *Capitaines au long cours* admitted as *Enseignes Auxiliaries* in case of insufficiency of officers.

The following conditions are necessary for promotion from a lower to higher grade:

Aspirants de 2e *classee, cadre* variable; required to pass graduation examination of naval school; are not officers.

Aspirants de 1re *classe,* two years on board Government ship, and pass examination, or one year at the School of Application and pass the required examination before a board presided over by a vice-admiral. Those failing to pass have a second year at the School of Application and are re-examined. Four places are reserved each year for the pupils of the Polytechnic School. Examination determines seniority.

Enseigne de Vaisseau, cadre 420; two years aboard ship as *aspirants de* 1re *classe, enseigne auxiliare* or first master (*Premier Maître*) of one of the essential maritime specialties; must pass the theoretical and practical examination. *Aspirants* coming from the Polytechnic School compete in the examinations with the others to fill vacancies. Two-thirds of the vacancies of this grade are given to *aspirant de* 1re *classe,* one-third to the *Enseigne Auxiliare* and 1re *maîtres.* If not enough of the latter, the vacancies are filled from the *aspirants de* 1re *classe.*

Lieutenant de Vaisseau, two years as *Enseigne* on board ship. Two-thirds by seniority, one-third by selection.

Capitaine de Corvette, grade suppressed, carried only for certain assimilations.

Capitaine de Frégate, four years as lieutenant, two at sea, but not on merchant ships. One-half by selection, one-half by seniority.

Capitaine de Vaisseau, three years at sea as *Capitaine de Frégate,* one year of which must be in command, or four years in the grade, two of which must be at sea on the condition of having been in command for two years since advancement to grade of lieutenant. Promotion to this grade is entirely by selection.

Contre Amiral, cadre 30; requirements, three years at sea as *Capitaine de Vaisseau* in command of a ship, or chief of staff of a squadron, or four years in grade, of which two in command of a division of three ships.

Vice-Amiral, cadre limited to 15; two years' sea service as rear-admiral of a squadron or division.

Amiral, cadre 2, in time of peace, 3 in time of war; none at present; is a dignity conferred upon a vice-admiral who has commanded in chief a naval force in time of war, or a naval army, and distinguished himself by eminent and meritorious war service.

Promotion by selection from the grade of *Enseigne* to *Capitaine de Vaisseau* is made from the table of advancement by the Council of Admiralty, or from office by the Minister for extraordinary service. Promotion by seniority depends upon position on the list in Annual Register.

Promotions to the grades of rear-admiral, vice-admiral, and admiral are absolutely by selection. These grades do not appear in the table of advancement (*tableau d'avancement*).

At the end of each year the Council of Admiralty receive the records of officers proposed up to the grade of captain. These records are examined by subcommittees, and after such examination the council prepares the *tableaux d'avancement* for each corps, from which are taken the officers, with certain exceptions, who are promoted by selection. The conditions of time of service are reduced one-half by war service, and are not considered in cases of brilliant service. Selection, commands, and other rewards are accorded in conformity with confidential reports or notes which commanders (*Chefs*) give at determined times, reaching Paris in November, and accompanied by lists in order of preference.

CIVIL BRANCH OF OFFICERS.

Mechanical engineers.—Exclusively recruited from the *Premiers Maîtres Mécaniciens* (first master mechanics), regularly proposed and inscribed in the table of advancement annually by a special board composed of the rear-admiral, president of the *Commission du Réglement D'Armement*, and of the captain member of that commission; of the captain president of the board of examination of engineers (*Mécaniciens*), the commander member of that board, and a *Mécanicien en-Chef*, and a *Sous Chef* of the *Bureau des Equipages*. Their position is not doubtful; they have all the conditions and all the advantages of the officers" estate. The title *Officiers Mécaniciens* is a grade, and not a mere employment.

The titles are *Mécanicien Principal de seconde classe* assimilating in rank with *Enseigne de Vaisseau; Mécanicien Principal de Première classe*, assimilating in rank with *Lieutenant de Vaisseau*; *Mécanicien en Chef*, assimilation, *Capitaine de Corvette* (lieutenant-commander); and *Mécanicien Inspecteur*, assimilation, *Capitaine de Vaisseau.*

CONDITIONS OF PROMOTION.

Mécanicien Principal seconde classe, selected from *Premiers-Maîtres Mécaniciens* who have served three years on board an armed ship as such (master mechanic) or, on board a school-ship as instructor for eighteen months, and eighteen months' sea service, or in the first category of the harbor as master mechanic in charge. Literary and technical proof is required, together with other papers.

Mècanicien Principal de première classe, three years' service as second, two of which sea-service. Half by seniority and half by selection.

Mécanicien en Chef, three years' service in first class, two of which at sea. Entirely by selection. Two last grades carried on the table of advancement.

Mécaniciens en Chef are attached to the staff of vice-admirals commanding in chief a squadron or naval force composed of several divisions. They inspect the machinery of the squadron, etc., and have duties similar to those of fleet engineer. *Mécaniciens Principaux de première classe* serve on board large ships where the machinery is of such a nature as to justify their employment. *Mécaniciens de seconde-classe* are employed on smaller vessels. They are responsible for the machinery. Their employment on shore is principally in connection with the instruction of mechanics.

Maritime engineers (*génie maritime*).—The naval constructors (*Génie Maritime*) are recruited from two sources: (1), Polytechnic School and leaving that school the Engineer Students take a two years' course at the School of Application specially established for them at Paris, under the direction of a superior officer of the *Génie Maritime*. From June 20 to September 19, they are sent to the arsenals and marine establishments, and at the end of their studies they are examined and if they fail are allowed a third year; (2), from the *Maîtres Principaux* and *Maîtres Entretenus* of the three classes. The *Maîtres* are called *Sous-Ingénieurs*, after a competitive examination preceded by a prepatory examination at the port. The preparatory examination is open to those graduates of the superior schôol for non-commissioned officers (*ecole supérieure de maistrance*) who have shown superior ability.

Élève Ingénieur, *cadre* 10; budget of 1885.

Sous-Ingénieur, third class, *cadre* 14; promotions to this grade as vacancies occur and after examination at school of application. One-sixth vacancies reserved for *Maîtres Entretenus* who have served one year as such, and to the *Maîtres Principaux* after competitive examination. In default of candidates this one-sixth goes to *Élèves Ingénieur.*

Sous-Ingénieur, second class, *cadre* 26; qualification two years as third class, promotion by seniority.

Sous-Ingénieur, first class, *cadre* 26; those in the first half of the list of *Sous-Ingénieur* are given this title. Promotion by seniority.

Ingénieur, second class, *cadre* 20; requirement three years' service in the inferior grade. One-half by selection; one-half by seniority.

Ingénieur, first-class, *cadre* 20; three years' service as second-class. Promotion by selection.

In the last two grades the selection is made from the table of advancement kept by the council of admiralty.

Directeurs des Constructions Navales.—Ten allowed, divided into first and second classes. Requirement three years' service as *Ingénieur* first class. By selection for the second class and by seniorty for nomination to first class.

Inspecteur-général.—One allowed, selected from *Directeurs*, after three years' service.

The duties of this corps include the building of engines and steam machinery. Those of the grade of *Sous-Ingénieur* first or second-class are sometimes required to serve for several months on board ship.

Hydrographic Engineers are recruited from the Polytechnic School. After two years as *élève* they are promoted as vacancies occur to sub-engineer, third class. Two only are allowed. Promotion to sub-engineer, second class, after two years' service in the inferior grade and is by seniority. Three years' service in this grade promotes to sub-engineer first class. Promotion by seniority. Three years' service as sub-engineer, first-class, promotes to hydrographic engineer, second class. Half by selection; half by seniority. Requirements for promotion to hydrographic engineer, first class, are three years in the inferior grade, and promotion is made by selection.

Promotion to hydrographic engineer-in-chief is by selection afteı three years' service as hydrographic engineer, first class.

Paymasters (*Corps du Commissariat*) are recruited from—

(1) *Élève Commissaires* admitted after competitive examination from *Licenciés en Droit* [licentiate in law], or failing in that, bachelor of letters (*Bachelier ès Lettres*), and of an age less than twenty-three years. Those who have served three years in the bureaux may compete up to twenty-five years of age.

(2) Polytechic School, two places, as *Aide-Commissaire*, after a special examination.

(3) Officers of the navy. Two places each year are given to *Enseignes* on application, and a fifth of vacancies in the grade of *Sous-Commissaire*, after competitive examinations, are given to lieutenants. In default of these candidates, vacancies are filled from the list of *Élèves Commissaire* and the *Aides-Commissaire.*

(4) *Sous Agents*, and clerks of the Commissariat of first and second class. Four places each year are reserved for this class of appointment. A competitive examination is required.

Sous-Commissaire.—One-fifth of the promotions to this grade explained above. The remaining four-fifths of the vacancies are filled from the *Aides-Commissaires* having at least three years' service in the grade; two-thirds by seniority, one third by selection.

Commissaire Adjoint.—The requirements are three years' service as *Sous-Commissaire*, one-half by seniority, one-half by selection, fifty-two allowed.

Commissaire.—Three years' service as *Commissaire-Adjoint* are required. By selection. In the last three grades the selection is made from the table of advancement kept by the Council of Admiralty.

Commissarie-Général.—Promotion to this grade by selection, disregarding table of advancement. Three years' service as *Commissaire* required; divided into two classes. Nine allowed. To pass from second to first class a decree is necessary, and promotion is by selection.

The numbers given are for the metropolitan list (France). Their duties are in connection with administrative interests of the navy, ashore and afloat, and officers of this corps are to be found on all commissions, councils, and boards, either permanent or temporary, where administrative interests are involved. Their precise functions are difficult to understand. A *Commissaire* is detailed for duty at each *Sous-Arrondissement*, who is charged with the verification of the *Caisse des Invalides*, and in the principal places of the *Arrondissement* with the accountability and with the mobilization of the reserves who concentrate at these places. At each *Quartier* is a *Commissaire Adjoint* or a *Sous Commissaire*, who holds the title of *Commissaire de L'Inscription Maritime.* He is the direct agent for the execution of the law, and the immediate representative of the Navy Department. He is the guardian of public order on board of French merchant ships, the magistrate for their ships' companies, the protector of the general interests of the fisheries, the recruiting officer for the naval army, the protector of persons and ships in distress on the coast, and the administrator of the *caisse des Invalides;* is in general the protector of the particular interest of the maritime population. At the dock-yards and on board ships their duties as to purchase of material, subsistence, pay, liquidation of expenses, and financial affairs are similar to those of our own paymasters.

Medical corps.—The personnel of this service is recruited from the Doctors of Medecine or from the *Pharmaciens Universitaires de* 1^re^ *classe*, who are appointed, without competitive examination, as *Médecins Auxiliaires de* 2^e^ *classe* or *Pharmaciens Auxiliaires de* 2^e^ *classe.* The candidate must fulfill the following conditions:

(1) Be a native born or naturalized Frenchman;

(2) Be less than 28 years of age, unless he has served the State long enough, previous to his appointment, to entitle him to retirement at the age of 53;

(3) Have a diploma of Doctor of Medicine, or possess the title of *Pharmacien Universitaire de* 1^re^ *classe;*

(4) Be pronounced fit for military service after an examination by a naval surgeon or an army surgeon.

He must produce certain certificates as to birth, morals, etc.

The *Médecins* and *Pharmaciens Auxiliairies de* 2^e^ *classe* are employed on shore, in the hospitals of the marine, at sea, and in the colonies. They wear the uniform of *Médecin* or of *Pharmacien titulaire de* 2^e^ *classe.* After two years they may be appointed, by decree, to the grade of *Médecin* or of *Pharmacien titulaire de* 2^e^ *classe.*

Advancement to the other grades in this corps is as follows:

For *Médicins* and *Pharmaciens de* 1^re^ *classe*, one-third by selection, two-thirds by seniority.

For *Médecins* and *Pharmaciens Principaux*, half by selection, half by seniority.

For *Médecins* and *Pharmaciens-en-Chef* and for *Directeurs du Service de Santé* promotion is entirely by selection. *Médecins* and *Pharmaciens Auxiliares*, Doctors of Medicine or *Pharmaciens Universitaires de* 1^{re} *classe*, coming from civil faculties, who are promoted to the grade of *Médecin* or *Pharmacien de* 2^e *classe*, if they agree to serve six years in the marine, receive a sum equal to the expenses necessary to obtain a university diploma.

The object of the Naval Medical Schools at Brest, Rochefort, and Toulon is to prepare the students (*élèves du service de santé de la marine*) for diplomas of Doctor of Medicine or of *Pharmacien Universitaire de* 1^{re} *classe.* The candidates coming from the faculties with university diplomas and who have been admitted into the corps as *Auxiliaires de* 2^e *classe* are instructed at these schools in the special duties required for service in the marine and in the colonies.

Students admitted to these schools must be not less than eighteen nor more than twenty-three years of age.

LAWS OF RETIREMENT.

An officer may be temporarily off the active list by reason of his being on special service or *en mission. Activité* proper ceases to exist at a fixed age for retirement or for passing in the *cadre* of reserve except for vice-admirals who have fulfilled the existing conditions, and they can be maintained indefinitely on the active list and be employed in time of peace up to seventy years of age.

The "reserve" is an intermediary position between activity and retirement, and is open only to Vice-Admirals, Rear-Admirals, Major-Generals, and Brigadier-Generals, who in this position are subject to the law of 1834, and can be called in time of war to command at sea and to active duty in the interior. This position counts for effective service for *la reforme* and retirement. Vice-Admirals, unless they demand their retirement, must pass in the reserve at the age of sixty-five years, and Rear-Admirals at sixty-two.

The age limits for retirement are not fixed by law, as is that for the passage of flag officers in the *cadre* of reserve, but is fixed by the decisions of the minister, who is free to alter them.

Age of retirement, or passing into *Réserve:* Vice-Admirals, sixty-five years; Rear-Admirals, sixty-two years; *Capitaine de Vaisseau*, sixty years; *Capitaine de Frégate*, fifty-eight years; *Lieutenant de Vaisseau*, fifty-three years.

From Broad Arrow, December 24, 1887:

> Lieutenants, after they have held the rank for fourteen years, and have fulfilled all the previous conditions of service, may elect to retire with rank and customary pension of *Capitaine de Frégate.*

The proportion of officers to ships is as follows:

1 flag officer to from five to six ships.
1 commanding officer to each ship and surplus of 53.
2 lieutenants to each ship and surplus of 178.

1 sub-lieutenant to each ship and surplus of 161.

226 midshipmen for (about) 260 ships.

149 mechanical engineers for (about) 260 ships.

1 paymaster to each ship and a surplus of 36. (Their duties, however, are in connection with the maritime inscription, etc., and many are detailed for duty in the *Arrondissements*, *Sous-Arrondissements*, and *Quartiers*, and have duties other than those of paymaster, as the term is understood in our Navy and in England.)

2 surgeons for each ship and a surplus of 29.

GERMANY.

This great military power, which can mobilize its fleet in less than a week, has but recently entirely re-organized its navy department with the object of attaining still greater efficiency. The Imperial decree which brought about the change is dated March, 1889, and is as follows:

SEPARATION OF THE COMMAND OF THE NAVY FROM THE ADMINISTRATION OF SAME.

> The Command-in-Chief of the Navy will hereafter devolve upon an Admiral appointed by me and who will command according to my directions. He will have the rank and privileges of a Commanding-General of the Army.
>
> The administration of the Navy will be intrusted to a Naval Secretary responsible to the Imperial Chancellor. He will have the rank of a High Imperial Official.

The administration is divided into two branches, the *Ober-Kommando der Marine* and the *Reichs-Marine-Amt.* Their offices are in separate buildings, and their respective scopes are intended to be as distinct as possible.

The senior officer of the Navy, a Vice-Admiral, has been appointed *Ober-Kommando der Marine* (Chief Commander of the Navy). He is also a permanent member of the Defense Commission. A rear-admiral is *Staatssekretär des Reichs-Marine-Amt* (Secretary of State for the Navy). He is a member of the *Bundesrath.*

Assuming that the *Marine-Amt* supplies all that is required for the navy's existence, it may be said that the *Ober-Kommando* regulates the manner of using such supplies. To make a comparison with a similar system prevailing in the German army, the *Marine-Amt* resembles in its duties the ministry of war and the *Ober-Kommando* to a certain extent the office of commanding-general of an army.

The general idea is that the *Marine-Amt* (navy department) proper builds everything and buys everything and the Commanding-Admiral directs the fleet when it is in commission.

The Emperor personally is Commander-in-Chief of the Navy, and as such has a Marine Cabinet, consisting at present of two officers, one a captain [*zur See*] Aide-de-Camp to His Majesty and Chief of the Cabinet, the other a Captain-Lieutenant. There is also a registrar, a civilian.

The offices of the Department are at Berlin. Those of the Marine Cabinet are in the same building with those of the *Ober-Kommando.*

The chief functions of the Chief of the Marine Cabinet are to advise the Emperor concerning military affairs, detail and promotion of officers. Formerly this list was made out at the admiralty and submitted by the Chief to the Emperor, who, not knowing or caring much about the navy, signed it immediately as presented. Now it is submitted in writing, with recommendations of both Commanding Admiral and Chief of Admiralty, and this is digested by the Marine Cabinet to eliminate possible favoritism and to comply with the policy of the Emperor, and in this way the Emperor can be better posted about the merits of juniors. The Chief of the Cabinet really acts as a sort of personal naval secretary to the Emperor, to smooth down differences between the two heads and to post him on details. Thus in matters of naval policy the Emperor has the advice of two responsible and competent heads, one of whom would naturally take the military side and the other the financial and parliamentary.

Ober-Kommando (chief command.)—This department has charge of detail of officers, assignment of complements, organization and relief of squadrons, education of personnel (both officers and men), selection and trial of new weapons, military (not financial) direction of navy-yards and stations, naval inspections, naval artillery inspections, torpedo inspections (as far as relates to naval matters), marine infantry inspections, and also the sailor divisions, dock-yard divisions, and apprentice divisions.

For a staff the Chief Commander has the following officers: 1 rear-admiral, Chief of Staff; 3 commanders, 5 lieutenant-commanders, the Surgeon-General of the Navy, and a major of sea batallion as Auditor of Justice. There are nine other assistants not officers.

The Reichs-Marine-Amt is under the immediate control of the Secretary of State for the Navy. It is divided into the navy department (*Marine-Amt*), financial department (*Verwaltungs Departement*) and the hydrographic office. There is also a Central Bureau to which are attached two commanders, and a military division in charge of a captain with two lieutenant-commanders, and a captain (military title) *à la suite*, as assistants.

The *Reichs-Marine-Amt* has charge of dock-yards, torpedo inspection (in all technical and administrative matters), superintendencies of stations, clothing bureaus, provision bureaus, station treasuries, naval accounts and financial affairs of educational establishments, artillery, mine, and torpedo depots, surveys, ships'-trial commissions, gun-trial commissions, light-houses.

Of the military personnel the following come under this branch of the administration: Gunners, ordnance and torpedo officers, and torpedo personnel of the mine systems, mechanicians, and torpedo personnel of the torpedo systems.

The Marine Department is in charge of a rear-admiral as Director, and prepares and submits plans and estimates for vessels, their armament,

	Seeoffizierkorps (sea officers' corps).		Maschinen-Ingenieurkorps (mechanical engineers).		Torpeder-Ingenieurkorps (torpedo engineers).		Sanitäts-Offizierkorps (medical corps).		Marine-Zahlmeister (paymasters).		Torpeder Offiziere (torpedo officers).		Feuerwerksoffiziere (gunnery officers).*		Zeugoffiziere (ordnance officer).*	Corresponding army rank.
	Admirale (Admirals)	....	....	....	....	....	....	....	....	....	....	....	....	....	....	General (cavalry or infantry).
4	Vize-Admirale (Vice-admirals).	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Lieutenant-general.
10	Kontre-Admirale (rear-admirals).	....	....	....	....	....	....	....	....	....	....	....	....	....	....	Major-general.
31	Kapitäne zur See (captains).	....	....	....	....	1	General-Arzt, 1. Klasse (surgeon-general, first class).	....	....	....	....	....	....	....	....	Colonel.
58	Korvetten-Kapitäne (commanders).	2	Stabs-Ingenieure (staff engineers).	....	....	5	Ober-Stabs-Aertze, 1. Klasse (chief staff surgeons).	....	....	....	....	....	....	....	....	Lieutenant-colonel and major.
115	Kapitän-Lieutenants (lieutenant-commanders).	4	Maschinen-Ober-Ingenieure (chief mechanical engineers).	1	Torpeder-Ober-Ingenieur (chief torpedo engineer).	5	Ober-Stabs-Aertze, 2. Klasse (chief staff surgeons, second class).	6	Marine-Ober-Zahlmeister (chief paymasters).	5	Torpeder-Kapitän-Lieutenants (torpedo lieutenant-commanders).	6	Feuerwerks-Hauptleute (gunnery captains).	5	Zeug-Hauptleute (ordnance captains).	Captain (infantry and artillery).
						28	Stabs-Aertze (surgeons).	....	....	....	....	....	....	....	....	
189	Lieutenants zur See (lieutenants).	16	Maschinen-Ingenieure (mechanical engineers).	1	Torpeder-Ingenieur (torpedo engineer).	24	Assistenz-Aerzte, 1. Klasse (assistant surgeons, first class).	24	Zahlmeister (paymasters).	4	Torpeder-Lieutenants (torpedo lieutenants).	9	Feuerwerks-Premier-Lieutenants (gunnery first lieutenants).	2	Zeug-Premier-Lieutenants (ordnance first lieutenants).	First lieutenant.
111	Unter-Lieutenants zur See (sub-lieutenants).	25	Maschinen-Unter-Ingenieure (assistant mechanical engineers).	5	Torpeder-Unter-Ingenieure (assistant torpedo engineers).	25	Assistenz-Aerzte, 2. Klasse (assistant surgeons, second class).	28	Unter-Zahlmeister (assistant paymasters).	7	Torpeder-Unter-Lieutenants (torpedo sub-lieutenants).	9	Feuerwerks-Lieutenants (gunnery lieutenants).	1	Zeug-Lieutenants (ordnance lieutenant).	Second lieutenant.
87	See kadetten (midshipmen).										These officers are stationed at the torpedo depots and dockyards, and are a staff corps, not sea officers (See-Offizier).		These officers are stationed at the dockyards and artillery depots, and are a staff corps, not sea officers, "See-Offizier" (line officers).		These officers are stationed at the artillery depot. This is a staff corps.	
47	Kadetten (cadets).															

* Titles are military.

There are 10 chaplains without military rank. Engineers of naval construction, engine or machine building and harbor works, are officers of the Imperial navy without military rank, and in the annual register appear under the head of dock-yard officers or functionaries (Werftbeamte).

Naval Construction.—3 directors, 9 chief engineers, 13 engineers.

Machine Construction.—3 directors, 9 chief engineers, 18 engineers.

Harbor or Hydraulic Works.—3 directors, 2 chief engineers, 1 engineer.

engines and boilers, and equipment of all kinds. A number of naval constructors and engine designers (*Maschinenbau-Ingenieure*) form part of this organization. The officer personnel of the department is as fofows: Rear-admiral, as Director; 1 captain, 3 commanders, 1 lieutenant-commander, 2 chief engineers of naval construction, 1 engineer of naval construction, 2 engineers of machine construction.

Verwaltungs-Departement (administration, financial) works in conjunction with the Marine Department as to estimates of money required for purposes of construction or repair, and independently on questions of pay and general working expenses.

Hydrographic office is in charge of a rear-admiral, who has among his associates 1 captain, 2 commanders, and 1 lieutenant-commander. The office has charge of hydrographic work, charts, and the like.

When the change of organization was determined upon it was decided to start in with a broad division between parliamentary and financial on the one hand, and military responsibility on the other, leaving the details to be worked out by experience, and after the system has been working for a reasonable length of time it is intended to define by suitable regulations the exact status of each branch of the administration.

PROMOTION AND RETIREMENT.

The appointment and education of naval cadets and their promotion up to the grade of sub-lieutenant, including the system of election to the corps of officers by their future comrades, has been fully described by Professor Soley, in his report on Foreign Systems of Naval Education, and by Lieutenant Staunton, in his article on Naval Training, etc., in No. VII of this series. There is no promotion out of turn, except for members of the royal family; but the requirements are rigidly enforced, and all through his career an officer is under the scrutiny of his superiors, who are required to send periodical reports to the Admiralty as to his qualifications, for what he is particularly qualified, his manner of performing duty, wherein he is wanting, his habits, his physical condition, whether he promises to be physically fitted for all kinds of duty, etc.

Commanders of stations, of squadrons, and commanding officers report upon junior officers to the Admiralty once in two years. The admirals and chiefs of stations report every six months on commanding officers. The papers are kept at the Admiralty, and are headed "Qualifications for Promotion." These papers are confidential. The first insertion in an officer's paper is made by the captain of his ship after two years' service or on his transfer; then the squadron commander and, after him, the station commander write their opinions on the same paper, which is then sent to the Admiralty, and a summary with the latter's comments is sent to the Emperor. Upon his next assignment to duty the officer's original paper is sent to his commanding officer or immediate chief, who at the end of the prescribed time adds his remarks and returns the document to the Admiralty. When the officer arrives at the head of the list, the station commander is notified that he is coming up for promotion, and his opinion as to his merits is required. If this is favorable the candidate is promoted; if unfavorable, the Chief of the Admiralty, through the Central Division, examines the case and usually the officer is notified that the Emperor does not longer require his services, and he resigns, or sometimes he is appointed to other functions under the state, if his abilities warrant. At any rate, he is not promoted, and the next on the list comes up for scrutiny. This is the usual case. If, however, the Chief of the Admiralty considers the judgment of the station commander harsh, or if there is any doubt, the officer is sent to some other station for three months, and if then the reports are sufficiently favorable he may receive his promotion.

For promotion to the grade of rear-admiral and above, the personal reports are written to the Emperor by the Chief of the Admiralty himself and the Emperor decides the case.

For the lower grades the sending of the reports to the Emperor is a form, in imitation of the army system where all promotions are made by the military cabinet of the Emperor. It is only in the higher grades in the navy that the Emperor intervenes in cases of promotion.

Papers relating to staff officers are never sent to the Emperor but are decided at the Admiralty.

There is no fixed age for retirement. But an officer is retired when the reports show that he has reached the limit of efficiency which of course varies in individuals. The requirements are so rigidly enforced that the average age for promotion to Korvetten-Kapitän (commander) is thirty-two years, and that to "Kapitan zur See" (captain) about forty two years, and for rear-admiral, about fifty.

Mechanical engineers are recruited from the chief machinists (*Ober-Maschinisten*). They are divided into two parts, the Baltic and the North Sea, nor is a change made from one to the other except through the Chief of the Admiralty.

Requirements for promotion to *Maschinen-Unter-Ingenieur* (assistant engineer) are two years' sea service as machinist in charge of watch in the navy, of which time ten months at least must have been on board an armor-clad, when the candidate belongs to one of the dock-yard divisions; or, if he belongs to the torpedo division five months of his two years' sea service must have been on board an armor-clad, and five months on board a torpedo-division boat. He must pass the required examination and be elected to the corps of officers by the Officers of Military Branch and the mechanical engineers of the station, and there must be a vacancy for him.

Promotions to mechanical engineer are only made when vacancies exist and after twelve months' sea service as assistant engineer; five months of the sea-service must be as engineer in charge.

For promotion to chief mechanical engineer the requirements are twelve months' sea service as engineer in charge on board an armorclad, and a vacancy.

For promotion to staff engineer (*Stabs-Ingenieur*) the requirements are qualification and a vacancy. Promotions are based on the periodical reports sent to the Admiralty.

Paymasters are taken from the paymaster aspirants. They receive their appointment and promotion from the Emperor. Paymaster aspirants are a class of non-commissioned officers (*Deck-Offiziere*). Service as such is open only to one year volunteers of the sea battalion or marine artillery who are unmarried and not over twenty-one years of age, and who are able to maintain (support) themselves during the year's volunteer service, and who have the necessary educational qualifications. Among the latter is a knowledge of English and French. They enter as candidates (*Anwärter*) and pass on to the grade of aspirant. The position of *Anwärter* is in rare cases given to others of the active marine service who have not been naval apprentices, and who are not over twenty-three years of age and have the other qualifications. Certificates are required to the effect that the candidate will be supplied with certain sums of money from private sources until he becomes an aspirant. He must have six months' service with the colors, be of good character, etc. Some of these requirements may be omitted in cases of special aptitude for this branch of the service, but such omissions are made only on the authority of the Chief of the Admiralty through the station commanders.

When all the conditions have been fulfilled, the candidate is sent to the paymaster's section of the station and goes through the various grades to aspirant, having a written and oral examination to pass for each grade. After two years' service as aspirant, one of which must have been on board ship in foreign waters, he comes up for another examination. If he successfully passes this and there is a vacancy he is promoted to *Unter-Zahlmeister* (assistant paymaster). Promotions to this grade are by turn and are made by the Emperor. The candidate for promotion must have proper recommendations from the officers under whom he has served.

Promotions to paymaster and chief paymaster are made by the Emperor when vacancies occur and with due regard to seniority.

Medical corps.—Young men who are German subjects, not over twenty-one years of age, who have diplomas from a gymnasium admitting them to a university, who have the necessary qualifications to serve as one-year volunteers, may be admitted to the Freiderich Wilhelm's Medical and Surgical Institute, or to the Royal Medical and Surgical Academy, both at Berlin, for education at the Government's expense for the medical corps of the army or navy. Certain papers as to family, etc., are also required, and the parents or guardian must give satisfactory proof that the student will be furnished certain money allowances from private sources. The course is four years. During the first six months the student serves with the colors, and this is credited to his one-year volunteer service.

Marine-Ingenieure (naval constructors and engine-builders).—Those who enter this corps, after passing the required technical examination, are called *Marine-Ingenieure-Aspiranten.* They must be graduates of one of the technical high schools, or of one of the polytechnic schools, and must have completed their term of military service. After becoming aspirants they have two years' practical work at an imperial dock-yard, when they have a second examination, if this is passed successfully and if there is a vacancy, they become *Marine-Unter-Ingénieur*, the lowest grade of the corps.

The method of recruiting men for the German navy, their organization, term of service etc., is fully described on pages 82, 83, and 84 of No. VIII, of this series. Also pages 22 and 23, same number. In the navy estimates for 1890–'91 provision is made for 9,502 rank and file in the two sailor divisions, and 3,799 in the two dock-yard divisions, and 515 in the boy division, being a total of 13,816.

Proportion of officers to ships.

1 flag officer to 5 vessels.
1 commanding officer to each ship and surplus of 11.
1 lieutenant-commander to each ship and surplus of 37.
2 lieutenants to each ship and surplus of 33.
1 sub-lieutenant to each ship and surplus of 33.
1 midshipman to a ship and surplus of 9.
1 mechanical engineer to each ship.
1 surgeon to each ship and surplus of 10.
58 Paymasters for (about) 78 ships.

ITALY.

The ministry of marine is composed of the following principal Directions and Offices: the reorganization went into effect January 1, 1890: Office of General Staff and of the Cabinet, General Direction of Naval Construction, General Direction of Artillery and Armament, General Direction of the Merchant Marine, Direction of the Hydrgraphic Service, Direction of the Sanitary Service, Office of Military Engineering (*genio militare*), Office of Revision, Auditor of Accounts.

The Minister at present is the senior officer of the corps of naval construction (*genio navale*). He is a member of Parliament, a deputy, and has held the office of Minister of Marine since March, 1884. The Under Secretary of State for the Navy is a rear-admiral, and he also is a deputy.

The royal decree, dated November, 1889, changing the organization, defines the rank and title of the officers to be selected for Chiefs of the Directions and Principal Offices, and states who shall be the extraordinary members of the Superior Council of the Marine and of the Committee of the Design of Ships and directs the Minister to regulate the reports of the Principal Offices under him, and the Under Secretary of State to indicate the method by which such offices are to be subdivided and to define the duties and establish the titles of the Secondary Offices. The extraordinary members of the Superior Council of Marine are the Chief of the General Staff, the General Directors, the Director of the Hydrographic Service, and the Chief of the Office of Revision. They are convened as such with deliberative vote when affairs pertaining to the service under their directions are to be considered. When the Council consider questions pertaining to the service of military engineering the officer in charge of that branch for the works of the navy will be present at the meeting in the status of an extraordinary member. The composition of the Council is as follows:

A vice-admiral as president; as ordinary members, a vice-admiral, vice-president, 1 rear-admiral, 1 inspector of naval construction (*Genio Navale*), 1 director-general (civil) of the ministry of marine, 1 captain with the duties of secretary. There are also two civilians who act as secretaries to the president. The members are appointed for two years by royal decree on the nomination of the Minister and are not changed unless for grave reasons. The following, by decree instituting the council, come under its cognizance:

Proposed laws relating to the mercantile marine; the naval budget; organization and normal establishment of the naval force; the normal establishment of the personnel in all its branches; the general rules of administration of the navy and mercantile marine; the composition of the fleet, of squadrons, and of divisions; tables of advancement; questions of seniority and retirement; projects of construction, changes, repairs, selling off and breaking up of ships; works in the arsenals and innovations and changes in projects already undertaken; the apportionment of work given out to private industry; programmes and conditions of examinations for entry in all branches of the service; affairs sent by the ministry of marine to other ministries for examination; reports, projects, etc., sent from commanders of squadrons and ships; special rules in every branch of the service. The Council is likewise chargedwith the inspection of naval establishments, of *personnel* and of *materiel* both of the navy and of the merchant marine, these inspections being ordered by the minister. All findings of the council have the prefix: "Heard before the Superior Council of Marine."

The Minister is not bound by the Council's findings. Questions are decided by a majority vote, and the findings are accompanied by an exposition of the discussion and motives. When affairs of the military personnel are treated of, the Civilian Director-General does not take part.

The opinions of the Directors General when they are called before the Council are entered in the minutes. An annual report is presented to

Parliament of the work of the Council. The report from which the above was taken continues:

> These seem large powers, but they are circumscribed by the fact that the Minister may choose to refer but little to the council for discussion. Their proceedings, unless the Minister of the time is in sympathy and accord, are rather academic though, of course, in a general way their views of service matters in any case go on record and must have a certain amount of weight. Their existence must have a conservative tendency and must also tend to give a certain continuity. The Council is merely an advisory body, and has no real administrative powers.

The following is the distribution of work in the ministry by decree, November 18, 1889:

Office of General Staff and Cabinet.—The Chief of the General Staff and of the Cabinet is a rear admiral. The office is divided into I, II, and III Divisions, and each of these into sections.

I DIVISION.—First section: Correspondence, general record of; particular correspondence of the ministry and of the Under-Secretary of State; library of the ministry; general archives; telegraph service; concentration and registration of royal decrees; personnel of the ministry and supervision of the accounts of the same, as well as of the telegram, postage and incidental accounts. Second section: Administration of the division, expenses of the offices of the ministry; all connected with this division are civilian officials, and belong either to the *Carriera Amiministratira e di Ragioneria* (administration and accounts) or to the *carriera d'ordine* (clerical force). Third section: Regulations and circulars, etc.; observance of proper form.

II DIVISION.—First section: Collection of data relative to ships; study of the force and composition of the fleet; questions of strategy and naval tactics; programme for manœuvres of the fleet. Second section: Study of the general character of the defense of the coast; organization of the auxiliary navy; formation of rules for officers of the naval reserve.

III DIVISION.—First section: Rules governing the general service discipline; service on board; tables for arming and fitting out of ships. Second section: Information.

A captain is in charge of the III Division, a commander of the II Division, lieutenant-commanders have charge of the sections in both divisions, and in addition to this personnel there are the following officers: 1 lieutenant-commander, 2 lieutenants, 4 paymasters. In other words, the Office of Chief of Staff has charge of the correspondence and confidential business immediately connected with the Minister and is also charged with the office of preparation for war and the Office of Naval Intelligence.

Direction General of Military Service.—Is in charge of a rear-admiral. The department is divided into three divisions, numbered IV, V, and VI, and each division into sections.

IV DIVISION.—Chief, a Captain. First section: Personnel of the corps of officers, and also of the officers *Del Corpo Reale Equippaggi;* second section: Movements of the fleet; military service; school-ships; school for engineer apprentices; naval academy.

V DIVISION.—Chief, a civilian official. First section: Recruiting. Second section: Crews of ships.

VI DIVISION (Accounts and Subsistence).—Chief, a civilian official. First section: Accounts of the personnel; naval academy and school for engineer apprentices; hospitals; relative to hydrographic office of semaphore service; naval orphan asylums; rewards. Second section: Accounts for fitting out and supplies for the navy; expenses for freight; provisions and quarters.

Direction General of Naval Construction.—Chief, one of the two Inspectors-General of Naval Construction. The other Inspector-General is Minister of Marine. Department is divided into VII, VIII, and IX Divisions.

VII DIVISION.—In charge of a chief engineer of first class of naval construction. First section: Chief, an engineer of first class of naval construction; naval constructions. Second section: Corps of naval constructors; technical personnel attached to the Direction; accounts and care of magazines (store-houses).

VIII DIVISION.—Chief of the division is a chief engineer of second class of naval construction (*genio navale*); machinery. First section: Chief, an engineer first-class of naval construction; motor apparatus; auxiliary engines; combustibles. Second section: Trials of engines; speed of ships; study of machinery; collection of data; various experiments.

IX DIVISION.—A civilian official in charge; accounts. First section: Naval constructors; keepers of store-houses; technical personnel attached to the direction; muster rolls and pensions of workmen; administration of laborers' fund; accounts connected with the breaking up of ships; statements and returns to the treasury; subsidies and rewards to the workmen employed by the direction and to their families. Second section: Collection and examination of purchased material; purchases by private contract; current accounts with contractors; verification and payment of expenses for purchases; accounts of store-house people; inventories; sale of obsolete material; accounts of expenses connected with the reproduction and maintenance of the fleet.

General direction of Artillery and Armament.—Chief, a rear-admiral. The X, XI, XII, and XIII Divisions belong to this direction.

X DIVISION.—Artillery. A commander in charge. First section: Large-caliber guns; system of armament for ships and fortifications; lieutenant in charge. Second section: Machine guns, small-arms, etc.; powder and explosives; pyrotechnics, magazines, powder-houses; lieutenant in charge.

XI DIVISION.—Submarine weapons. Commander in charge. First section: Submarine weapons and material for same; systems of, on board ship and in coast defenses; lieutenant in charge. Second section: Electric apparatus and electric material in general; disposition of, on board ship and on shore; lieutenant in charge.

XII Division.—A captain in charge. One section. Equipment and other service pertaining to the Direction of Armament; torpedo nettings.

XIII Division.—Accounts. Civilian official in charge. First section: Administration of the technical personnel belonging to the Direction; muster rolls; pensions of workmen; administration of the funds of laborers; subsidies and rewards to workmen employed by the Direction; statements and returns to the treasury; Second section: Collection and examination of purchases of material; purchases by private contract; current accounts with contractors; verification and payment of expenses for purchases; inventories; accounts of store-house people; sale of obsolete or condemned material.

Direction General of the Mercantile Marine.—Civilian in charge. XIV, XV, and XVI Divisions.

XIV Division.—Personnel of the captains of ports; police; health.

XV Division.—Ports and coasts; grades in the merchant marine; crimes, offenses, etc.

XVI Division.—Premiums for merchant marine. Superior Council of Merchant Marine; Statistics. The divisions are divided into sections among which the work is distributed.

Direction of Hydrographic Service.—Rear-admiral in charge. First part: Hydrographic service. Second part: Semaphore service. Lieutenant-commander in charge. There are only three officers attached to the direction, one of whom is a paymaster.

Direction of Sanitary Service.—Medical Inspector in charge. First part: Sanitary service. Medical officer, with relative rank of commander, in charge. Second part: Medical and pharmaceutical personnel. Scientific laboratories. Medical officer with relative rank of commander in charge. No other officers attached to the direction.

Office of Military Engineering.—Colonel of military engineers in charge. Fortifications, hydraulic operations, buildings. First section: Construction, repair, and improvement of. In charge of a major of engineers. Second section: Contracts, accounts, etc.

Office of Revision.—Pay inspector in charge. He has the relative rank of rear-admiral. Divided into four parts. First part: Pay Director in charge with relative rank of captain. Personnel of the commissariat and local clerks: general service. Second part: In charge of a chief paymaster, first class. Revision of the accounts of all the corps and of military institutes. Third part: Chief Paymaster of second class in charge. Revision of accounts on board ship. Fourth part: Chief Paymaster, second class, in charge. Revision of the accounts of the directions having charge of work. Eighteen paymasters, first class, are attached to this office.

Office of Auditing Accounts.—A civilian in charge.

Committee on Designs of Ships.—Is composed of an inspector of the construction corps as president, two inspectors same corps, ordinary members, one chief mechanical engineer with rank of Director, and one chief engineer, first class, construction corps, as ordinary members. As extraordinary members there are three commanders. In addition there are eight draughtsmen, with an engineer, first class, of construction corps, in charge. The committee is charged with the preparation of plans and estimates of ships and machinery. They get out the specifications and study such technical questions as may be assigned to them by the Minister. The extraordinary members are more especially charged with questions relating to armament and equipment. The committee is responsible for the correctness of design and calculations, and all designs and documents are laid before the Minister with a *procés-verbal* of the discussion and findings relating to them.

The Commission of Appeals from Draft (*Commissione dei Ricorsi per la leva di Mare*) has a vice-admiral for president. The other members are civilians.

The *Tribunale Supremo di Guerra e Marine* is a mixed court for military and naval cases. Neither of these committees have anything to do with the ministry of marine, and need no further description.

Number of officers in each grade, laws of promotion, retirement, etc., 1890.

Title.	No.	Rank with—	Age of retirement.
Ammiraglio (Admiral)	1		Royal decree 1885.
Vice-Ammiraglio (Vice-admirals)	5		65
Contr' Ammiraglio (Rear-admirals)	15		60
Capitani di Vascelli (Captains)	46		55
Capitani di Fregata (Commanders)	59		52
Capitani di Corvetta (Lieutenant-commanders)	56		50
Tenenti di Vascelli (Lieutenants)	309		45
Sottotenenti di Vascelli (Sub-lieutenants)	167		
Guarda Marina (Midshipmen)	78		
	736		
GENIO NAVALE (*Corps of naval engineering*).			
Ufficiali ingegneri (*naval constructors*).			
Ispettori Generale (Inspector-general)	1	Vice-admiral	
Ispettori (Inspectors)	2	Rear-admiral	
Direttori (Directors)	6	Captain	
Ingegneri Capi di prima classe (Chief engineers, first class).	6	Commander	
Ingegneri Capi di seconda classe (Chief engineers, second class).	6	Lieutenant-commander	
Ingegneri di prima classe (Engineers, first class).	30	Lieutenant	
Ingegneri di seconda classe (Engineers, second class).	12	Sub-lieutenant	
Allievi ingegneri (Pupils)	6		
	69		

Number of officers in each grade, laws of promotion, retirement, etc., 1890—Continued.

Title.	No.	Rank with—	Age of retirement.
GENIO NAVALE (*Corps of naval engineering*).—Continued.			
Assistants.			
Assistenti, di prima classe	8		
Assistenti, di seconda classe	7		
	15		
Ufficiali Macchinisti (*Mechanical engineers*).			
Capo Macchinisti principali (Chief, with rank of director).	1	Captain	
Capo Macchinisti Principali (Chiefs, first class)	3	Commander	
Capi macchinisti, principali	8	Lieutenant-commander	
Capi macchinisti, di prima classe	42	Lieutenant	
Capi macchinisti, di seconda classe	47	Lieutenant	
Soto-capi macchinisti	77	Sub-lieutenant	
	178		
CORPO SAINTARIO.			
Medical Corps.			
Ispettori Medico	1	Rear-admiral	
Direttori	3	Captain	
Medici capi, di prima classe	8	Commander	
Medici capi, di seconda classe	13	Lieutenant-commander	
Medici, di prima classe	59	Lieutenant	
Medici, di seconda classe	61	Sub-lieutenant	
	145		
CORPO DI COMMISSARIATO.			
Paymastere.			
Ispettori	1	Rear-admiral	
Direttori	4	Captain	
Commissari Capi, di prima classe	13	Commander	
Commissari Capi, di seconda classe	20	Lieutenant-commander	
Commissari, prima classe	121	Lieutenant	
Commissari, seconda classe	113	Sub-lieutenant	
Allievi Commissari	20		

No one receives promotion unless he has the necessary qualifications and has passed the required examination. Promotion is by seniority, by selection, and by competitive examination.

Those promoted by selection must fulfill the other conditions for promotion. Seniority of those who enter by competitive examination is determined by the order in which they pass that examination. The same applies to those who are promoted by competitive examination.

Midshipmen are graduates of the naval academy. Requirements for promotion to midshipman from grade of non-commissioned officer are, two years' service as non-commissioned officer, pass the examination, and be not more than thirty years of age.

Those of the enlisted force who, at the time of entering the service, have a certificate as "captain of long voyages" and have had two years' war service may be made midshipmen. Promotion from warrant officer to midshipman is only made in case of great insufficiency of officers.

Promotion.

From—	To—	Requirements.
Midshipman	Sub-lieutenant	2 years in grade; 18 months' sea service.
Sub-lieutenant	Lieutenant	3 years in grade; 2 years' sea service.
Lieutenant	Lieutenant-commander	4 years in grade; 3 years' sea service.
Lieutenant-commander	Commander	2 years in grade; 12 months' sea service, or 6 months' sea service, if during his 3 years' sea service as lieutenant he has command of a vessel.
Commander	Captain	3 years in grade; 18 months' sea service.
Captain	Rear-admiral	Do.
Rear-admiral	Vice-admiral	2 years in grade, at least 6 months as commander of a squadron in effective sea service or as chief of staff.
Vice-admiral	Admiral	Only takes place when a vice-admiral as commander-in-chief of a fleet in time of war has distinguished himself before the enemy.

In time of peace midshipmen are promoted by seniority; sub-lieutenants by competitive examination; lieutenants and lieutenant-commanders two-thirds by seniority, one-third by selection; commanders, one-half by selection, one-half by seniority; captains and rear-admirals only by selection.

In time of war promotion in all corps is only by selection, and the period of time in a grade, and the length of sea service required is reduced to one-half of what it is in time of peace, and all rules disregarded altogether in cases of promotion for extraordinarily heroic action.

The power of provisional promotion to officer's rank may be delegated to a commander-in-chief and by royal decree, afterwards confirmed, if certain conditions have been fulfilled.

GENIO NAVALE (CONSTRUCTION CORPS).

Graduates from the naval academy who have fulfilled the conditions are admitted as pupils in this corps, so also are the following: Naval constructors' assistants, first class; machinists of the steam engineer branch not over thirty years of age and who pass the required examination. Individuals from the corps of enlisted men may also become pupils, providing they have had 2 years' naval service and can produce a diploma either as naval architect or engine designer. Only half the vacancies in the grade of assistant constructor, second class (ingegneri 2ª classe) are filled from the "pupils" and these must have passed through the special course with successful results. The other half are thrown open to civilians not over twenty-five years of age, graduates of universities, with engineer diplomas, or graduates of other higher educational institutions. They must compete in the examinations with the pupils, midshipmen, and mechanical engineers, third class. Assistant naval constructors, second class, must successfully pass through a special course before they can be promoted.

From—	To—	Requirements.	Remarks.
Ingegneri di 2ª classe (assistant constructors, second class).	Ingenere di 1ª classe	3 years in grade, of which 1 year at an arsenal or dock-yard.	In time of peace ingegneri, di 2ª classe, are promoted by competitive examination; ingegneri, di 1ª classe, two-thirds by seniority, one-third by selection; ingegneri capi, di 2ª classe, oné-half by selection, one-half by seniority; ingegneri, di 1ª classe and above that grade only by selection.
Ingegnere di 1ª classe	Ingeneri capi di 2ª classe (chief engineer, second class).	4 years in grade, of which 2 in a dock-yard or arsenal and 6 months on board ship.	
Ingegneri capi di 2ª classe.	Ingegneri capi 1° classe.	3 years in grade, of which 2 in a dock-yard or arsenal.	
Ingegneri capi 1ª classe.	Direttori	do	
Direttori	Inspettori with relative rank of rear-admiral.	do	
Inspettori	Inspector with relative rank of vice-admiral.	2 years in grado	
Mechanical engineer branch.			
Sott'uffiziali di 1ª classe [chief warrant officer.]	Sotto capi macchinisti (relative rank of sub-lieutenant).	Required examination, 2 years' continuous sea service, during which time there must have been at least 1,500 miles steaming (fires lit).	In time of peace promotion in the three lower grades is half by seniority and half by selection; above those grades entirely by selection.
Sotto capi macchinisti	Capi mac. 2ª classe	3 years in grade, 2 at sea	
Capi macchinisti di 2ª classe.	Capi macchinisti 1ª classe.	3 years in grade, 2 of which sea service.	
Capi macchinisti di 1ª classe.	Capi macchinisti principali.	4 years in grade, 3 years' sea service.	
Medical officers.			Civilians with doctors' diplomas from medical universities who pass the competitive examination and are not over 30 years of age are entered as medici di 2ª classe. In time of peace medici di 2ª classe are promoted by competitive examination; medici di 1ª classe and medici capi di 1ª and di 2ª classe, two-thirds by seniority and one-third by selection. Above the grade of medici capi di 1ª classe only by selection.
Medici di 2ª classe	Medici di 1° classe	3 years in grade, of which 18 months' sea service.	
Medici di 1° classe	Medici capi di 2ª classe	4 years in grade, of which 18 months' sea service.	
Medici capi di 2ª classe.	Medici capi di 1° classe	3 years in grade	
Medici capi di 1° classe.	Direttori	do	

PAYMASTERS.

Graduates of the naval academy who qualify for the paymasters' corps are made pupils *allievi commissari*. The following may also be admitted as pupils if they succeed at the competitive examination: Non-commissioned officers who have been two years in the grade and are not over thirty years of age, and civilians graduates of a college not over twenty-five years of age.

From—	To—	Requirements.
Allievi-Commissari	Commissari, di 2ª classe	3 years in grade, 6 months' sea service.
Commissari, di 2ª classe	Commissari, di 1ª classe (assistant paymasters, first class.)	2 years in grade; 1 year's sea service.
Commissari, di 1ª classe	Commissari-capi, di seconda classe, (chief paymasters, second class).	4 years in grade; 1 year's sea service.
Commissari-capi, di seconda classe.	Commissari-capi, di 1ª classe	3 years in grade.
Commissari-capi, di 1ª classe	Direttori	Do.

In time of peace *Allievi-Commissari* are promoted by seniority. *Commissari di seconda classe* (assistant paymasters, second class); by competitive examination; *Commissari di prima classe* and *Commissari-Capi di seconda classe*, two-thirds by seniority and one-third by selection. Above the latter grade only by selection.

Proportion of officers to ships.

1 flag officer to 4 vessels.
1 commanding officer to each vessel and a surplus of 16.
Of officers to do duties of executive, navigator, and watch officer (being the lieutenant-commanders, lieutenants, and sub-lieutenants), there are 6 to every ship.
2 mechanical engineers to each ship.
1 surgeon to each ship and surplus of 56.
3 paymasters to each ship.

RUSSIA.

ORGANIZATION AND DISTRIBUTION OF WORK OF ADMINISTRATION.

The Emperor, who has supreme command of all naval as well as military forces, exercises his authority in the navy through an officer (usually a grand duke) whom he appoints and who has the title of General Admiral. In addition to being the head of the naval establishment the General Admiral is also President of the Board of Admiralty.

The ministry of marine is under a minister appointed by the Emperor.

His title is not exactly that of Minister, but rather that of Administrator (*gérant*). The present incumbent is an admiral. He has an aide-de-camp, either a captain or lieutenant, at present the latter.

The department proper is divided as follows:

1. Admiralty Board.
2. General Staff; [Headquarters Staff.]
3. Department of Matériel and Supplies.
4. Law Bureau.
5. Hydrographic Bureau.
6. Medical Bureau.
7. Scientific Committee.
8. Technical Committee.
9. Buildings Committee (in arsenals, etc., civil engineering).
10. Secretary's Office.
11. Archives.

Admiralty Board.—President, the General Admiral; vice-president, the Minister of Marine; members: four admirals and five vice-admirals, or rear-admirals, and one lieutenant-general. The members have other duties in the ministry.

This board revises estimates for submission to the Council of the Empire, fix and change all general rules and regulations for guidance of committees and bureaus, inspect vessels and all naval establishments, and report recommendations to General Admiral.

General Staff.—Chief of Staff, admiral or vice-admiral, Assistant Chief of Staff, rear-admiral, twenty-one naval officers of which at least eight must be captains or commanders, and at least three below the latter grade, four civil officers.

Duties of General Staff: The Chief (at present a vice-admiral) is the immediate commander of the personnel under the Minister and is responsible for its efficiency and also that of the fleet.

Originates all orders for movements of fleets or vessels in time of peace and war.

Prepares mobilization plans, and organization of reserve and commercial and volunteer fleets. Draws up proposed plans of action in accordance with information furnished him as to force and disposition of foreign fleets. Prepares annual cruising programme for the fleet and inspects all vessels and naval establishments. He may (and in summer of 1888 did) command the squadrons of manœuvres in the Baltic. In general he is the Commander of the Navy as a fighting force. His plans and proposed actions are submitted to the Minister for approval. He replaces the Minister in his absence.

The Assistant Chief of Staff (at present a rear-admiral) has immediate control of the personnel of the General Staff and supervises the working of the same. He has charge of the detail of all officers subject to the approval of the Chief of Staff—captains and above are appointed by the Emperor—corresponds with all departments and establishments concerning the personnel. He replaces the Chief in the latter's absence.

The General Staff is divided into sections.

First Section—Control of the Fleet. Is directly under the Chief of Staff, and its duties may be summed up as follows: Knowledge of exact condition of the fleet, and propositions for its complete preparation for action; annual cruising scheme; instructions to commanders at home and abroad; plans for cruiser warfare; compilation of data of all foreign mercantile navies, ports, coaling stations, trading routes, and foreign commerce; preparation of mobilization plans for fleet and auxiliaries; Intelligence Office, especially data concerning foreign navies and coast defense; submarine cables and telegraph lines; correspondence with naval attaches and consular officers; fleet manœuvres, reviews, ceremonies; regulations for training, drills, inspections, etc.

Second Section—Personnel. Under the Assistant Chief of staff, and deal swith appointment, promotion, retirement and detail of all officers, and questions relating to pay, calling out, detail and dismissal of seamen, rewards, punishments, etc., to officers and men; correspondence relating to the personnel, finance and accounts of General Staff.

The Secretary's Office (*Chancellerie*). Preparation of all correspondence from various departments for submission to the Admiralty Board and record of proceedings of the same; compilations of the reports from various departments and port administrations in the form of an annual report on the navy to be submitted to the Emperor. A law officer is attached to the *chancellerie* for legal opinion.

Department of Material and Supplies.—Chief of Department, a vice or rear-admiral, and employs in all twenty-seven officers and officials.

The general duties of this department are the distribution of work to the arsenals and private establishments; supply of articles of standard pattern to ports; formation of reserves of stores, and accounts of the whole naval establishment. As regards armament, equipment, and stores, this department is limited to keeping up the established allowances for ports, ships, and reserves. It has no direct dealing with officers in command, who communicate with the port authorities. It settles with contractors, subject to the inspection and acceptance of articles by the port authorities. It is responsible for the maintenance of proper supply of stores of all kinds, and for the quality and economy of work at the ports. It controls the issue of stores and has the power of taking account of stock. It is divided into the following sections:

Construction section: Chief, the Head of the Department, three senior and two junior officers of the construction branch as assistants. Is charged with the execution of the ship-building programme and must have data to date concerning all ships building at home and abroad, condition of their armament, building resources of ports, cost of labor, etc., quantity, quality, and distribution of artillery and torpedo material. Prepares the annual ship-building programme, and that of repairs and re-armaments. This is done in accordance with the specifications of the Technical Committee, upon which the section notes its remarks and refers back to the Committee for submission to the ministry of marine. In accordance with programme it prepares estimates and makes contracts or orders work at the ports.

Stores Section: Chief of Section—assisted by two senior and six junior officials (civilians)—has charge of supplies of wood, metal, hemp, provisions, clothing, fuel, and all other stores. A reserve is maintained at each port in accordance with lists prepared by the Head of Department and approved by the Minister of Marine. This reserve stock can not be drawn upon for current use, but is for emergency and mobilization. This section sees that articles of standard pattern only are in stock, and sees to their being kept in proper condition and issued in accordance to prescribed regulations.

This section prepares contracts for stores, and the chief is responsible that they are properly carried out.

Requisitions for stores from the ports, together with detailed information of stock on hand, must be sent in before the first of October each year. Hence the estimates are prepared and submitted to the Admiralty Board, who modify them to conform to the sum allotted to the navy by the Finance Minister.

Accounts Section: The personnel is the same as preceding section. Has charge of accounts of money and stores for entire naval establishment; prepares estimates of receipts and expenditures based upon data from different branches, which are submitted to the Minister of Marine for change or approval, and by him to the Admiralty Board, whence they are presented to the imperial council on the 1st September. This section notifies each department of the sums allotted, distributes credits, pays expenditures, keeps accounts of construction and Store Department, furnishes credits to vessels abroad and audits their accounts, and pays officers and employés attached to the Ministry of Marine. It is furnished monthly by the port authorities with a statement of their expenditures. It forwards monthly to the Imperial Control Department a statement of expenditures of department of Construction and Stores.

The store ledgers of all establishments are sent to this section for inspection and verification.

Hydrographic Bureau.—The personnel of this bureau consists of 1 vice-admiral or lieutenant-general (or admiral or general*), 1 rear-admiral or major-general, 1 captain or commander, 12 captains, commanders, or lieutenants; 1 major-general or colonel, 2 civilian officials.

The Bureau has charge of all hydrographic work, and of compasses, chronometers, etc.

Medical Bureau.—Has as chief, the Medical Inspector of Fleet; two naval surgeons, two civilian officials, assistants. Has control of medical service of navy. Selects stores, etc. Commends officers for appointment.

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* The grade of general, is given in the navy when an officer comes up for promotion to general rank, but who has not had sufficient sea service to warrant his being made an admiral.

Technical Committee.—Corresponds to Conseil des Travaux in the French Admiralty.

Its personnel is as follows:

	Total.	Artillery.	Torpedo.	Naval construction.	Mechanical engineering.
Chief Inspectors	4	*1	†1	1	1
Assistant Inspectors	9	2	‡2	3	2
Senior Officers	7	2	2	2	1
Junior Officers	8	2	....	5	1
Chief Draughtsmen	3	1	....	1	1
Draughtsmen	10	2	2	4	2
Inspectors of Accounts	3	1	....	1	1
Senior Accountants	5	....	1	2	2
Junior Accountants	6	....	....	3	3
Official in Charge of Museum	1	....	....	....	....
Official in Charge of Models	1	....	....	....	....

* Rear-admiral. † Captain. ‡ Commanders.

This committee has cognizance of all advance in ship and engine construction, ordnance and torpedoes, judges on their adoption, and disseminates information concerning the same to special corps. Considers plans and specifications for building sheds, docks, etc., patterns of guns, carriages, torpedos and their accessories. Considers reports of boards on defects and repairs and prepares estimates of latter. Issues instructions for proof of guns, makes range tables, and draws up programme of artillery and torpedo experiments. Is provided with detail drawings of vessels and their armaments and engines, and keeps informed of their condition. Considers plans of vessels under construction (if a captain is appointed to such, he is present at all consultations concerning same). Full information as to condition and capacity of navy-yards and private establishments.

This committee verify the accounts of the ports and workshops in St. Petersburg direct; elsewhere by means of inspectors.

The reports of inspection are sent annually by the president to the Minister of Marine.

Under this committee are subcommittees.

First. On Artillery Experiments. The president of which is *ex officio* a member of the Technical Committee. He receives from the Inspector of Artillery the programme of experiments and carries them out. He reports results to the Chief Inspector, who refers them to the Technical Committee, who report findings to the Minister.

Second. The Buildings Committee, which considers plans of all buildings in yards, docks, workshops, etc. Recommendations are submitted to the Technical Committee, who transmit decisions to the Minister. The president of this committee is the Inspector of "Building" Engineers, and can inspect personally or by deputy all works under cognizance of this committee.

The naval museum and depots of plans and models are under the Technical Committee.

The Scientific Committee.—Personnel as follows: 4 rear (or vice) admirals or major (or lieutenant) generals; 2 captains or commanders; 1 captain, commander, or lieutenant; 3 civil officials.

The associate members are the Chief of the Hydrographic Bureau, the Chief of the Naval Academy, the Chief of the Technical School.

The committee deals with the improvements in navigation, hydrography, meteorology, naval tactics, signaling, life-saving, prevention of collisions, and all inventions for naval purposes not under the Technical Committee.

It inspects all naval, astronomical and meteorological observations, light-houses and life-saving stations, surveying ships and expeditions, and issues regulations regarding same. It has supervision of all naval education establishments. The Naval Library, the publication of the Naval Magazine, and the diffusion generally of naval science.

Archives.—One chief, two assistants. All correspondence over three years old is kept here. It is turned over in three classes: (1) those to be destroyed; (2) likely to be referred to for a stated period; (3) for permanent record.

The following is a list of different grades on duty at the Admiralty in 1887:

Admirals	20
Captains and commanders	21
Lieutenants and sublieutenants	12
Artillery officers	18
Pilots (for port of St. Petersburg)	55
Constructors	17
Naval engineers	14
Civil engineers	13
Warrant officers	13
Surgeons	3
Civil officers and clerks	60

The above reorganization was effected about four years ago. Previous to that time they had a bureau system with divided responsibility somewhat similar to our own.

Numbers, grades, promotion, retirement, etc., annual register, 1890; *active list.*

Vice-admirals	21
Rear-admirals	23
Captains, first class	64
Captains, second class	220
Lieutenants	521
Midshipmen	503
Officers marine artillery	98
Officers of navigation (pilots, etc.)	250
Naval constructors	93
Mechanical engineers	332
Naval engineers (civil engineers)	47
Surgeons	204

In order to clear the lists of officers incapable of good service, limits of age and minimum of service were set in 1887 as qualifications for promotion; but these rules were not enforced until January 1, 1889. Those retiring voluntarily before that date received full pay, but those retired by action of the law receive only a small pension. Many voluntarily retired.

Officers for the military or executive branch are taken from the naval school at St. Petersburg, where the course is six years. Admission to the school is open to sons of noblemen, of naval and military officers, and of hereditary honorary citizens. They are required to pass a competitive mental examination, and must be physically fit. Forty young men are annually admitted to the school free of all charge for their education; twenty-seven being educated at expense of navy department and thirteen having scholarships.

Promotion is by seniority and by selection. A lieutenant must serve at least four years in his grade before he can be promoted; a captain, second class (commander), eight years; and a captain, first class, eight years. Only those officers having rank above lieutenant are promoted by selection in time of peace, five years' service in grade being required. Officers having the rank of lieutenant and below may be promoted in time of war by selection after three years' service in grade. These rules apply to officers of all branches of the service. Rear-admirals retire at the age of sixty; captains, fifty-eight; commanders, fifty-one; and lieutenants, forty-seven.

Mechanical engineer branch.—The officers of this branch are taken from the pupils of the Marine Technological School at St. Petersburg who have gone through the special course for naval constructors and engine builders. They enter the service, after passing the required examinations, as assistants second class. They may then be sent on board of merchant steamers for practical experience, and while so employed receive about $45 per month. They are divided into two parts, those for service on shore and those for service on board ship.

There are usually on the list for service on board ship—

Naval architects of machine constructions, with relative rank of captain, first class	8
Mechanical engineers, with relative rank of captain, second class	59
Assistants, first class, with relative rank of lieutenant	109
Assistants, second class, with relative rank of sublieutenant	75
Total	251

For service on shore—

Inspectors of machine construction, with relative rank of rear-admirals	3
Naval architects of machine construction, with relative rank of captain, first class	8
Mechanical engineers, with relative rank of captain, second class	28
Assistants, first class, with relative rank of lieutenants	9
Total	47

Promotion is two-thirds by seniority, one-third by selection. Assistants, second class, are required to have four years' service in grade, either twelve months' service on board ship in foreign waters or twenty-four months in home waters and pass the examination given them by the Technical Committee before they can be promoted. Assistants, first class, same conditions, except they must have eight years' service in grade, and the ship service is doubled. Mechanical engineers must have five years' service in grade and twelve and twenty-four months' service on board ships of first or second class of over 3,000 I. H. P. Naval architects of machine construction and inspectors who have served more than five years in grade receive an increase of pay.

Engineers of Naval Construction are educated at the Marine Technological School at St. Petersburg, and after passing the required examinations are made assistants, second class.

The numbers in the grades are as follows:

Inspectors, with relative rank of rear-admiral	4
Engineers, first class, with relative rank of captains, first class	15
Engineers, second class, with relative rank of captains, second class	23
Assistants, first class, with relative rank of lieutenants	25
Assistants, second class, with relative rank of sublieutenants	24
Total	91

Promotion: One-third by selection; two-thirds by seniority. Assistants, second class, can only be promoted after four years' service in grade, and assistants, first class, must serve eight years in grade, have had experience in naval construction, and perform the tasks set them by the Marine Technical Committee before they can be promoted. Engineers, second class, are required to have five years' service in grade. Engineers, first class, and inspectors who have served more than five years in grade, receive an increase of pay.

Surgeons—There is a special school at Cronstadt for this class of officers. Boys of all classes, from thirteen to sixteen years of age, are admitted who are able to read and write, and who know the four rules of arithmetic and are physically qualified. After a four years' course the students are sent to the hospitals for practical experience. Their education is at the expense of the Government.

Proportion of officers to vessels.

1 flag officer to 3 ships and a surplus of 9.
1 commanding officer to each ship and a surplus of 116.
3 lieutenants to each ship and a surplus of 17.
3 midshipmen to each ship.
2 mechanical engineers to each ship.
1 surgeon to each ship and a surplus of 36.
567 Administrative employés.

AUSTRIA.

There is no ministry of marine in Austria, but the affairs of the navy are managed from the Marine Section of the War Department, the Chief of the Section being appointed by the Emperor from among the flag officers on the active list of the navy. Although the Chief of the Marine

Section is only the representative of the Minister for War in marine affairs, he is also the *Marine-Commandant*, the Military Commander-in-Chief of the Fleet, in peace and in war, and may be called by the Emperor to take actual command afloat. His authority is established by statute and in the command of the fleet he is independent, and he is responsible to the Emperor for the discipline and interior control and efficiency of the navy from a military point of view. But in financial matters he is subordinate to the Minister for War, who is the responsible Parliamentary Minister for *all* war expenses, and though he prepares the naval budget, it is presented by the Minister for War as part of the war budget. The present Chiet of Marine Section is the senior officer on the active list of the navy, an admiral. Attached to the Section is a Vice-Admiral as Assistant. He represents the chief in his absence. A captain and two lieutenants are also on the personal staff of the Marine Commandant. The official title of the head of the navy is *Marine-Commandant und Chef Der Marine Section.*

The section is divided as follows:

Private Cabinet (*Präsidialkanzlei*), Operations Division (*Die Operationskanzlei*), First and Second Groups of Officers for transacting business, (*Geschäftsgruppe*), a Division of Justice, and a Disbursing Office.

(1) *Private Cabinet* has for Chief a captain; assistants, one lieutenant-commander, three lieutenants, and one lieutenant-colonel. This latter officer belongs to an abolished corps of marine infantry, some of whose officers are employed in the administration. All the correspondence of the Marine Section passes through the Cabinet, and it is charged (so far as they do not conflict with the duties of the Operations Division) with questions of military service and discipline, education and training, putting ships in and out of commission, hydrographic and sanitary matters, and general improvement in organization.

(2) *Operations Division.*—Chief, a captain; assistants, one lieutenant-commander and four lieutenants. Its duties are those of a General Staff. They deal with such questions as the best disposition to be made of the navy, in peace and in war, study of tactics, naval operations, mobilization, etc., collection of information (naval intelligence), and all questions of preparation for war. They are advisory and submit their decisions to the Commander-in-Chief.

(3) *First Bureau* (1. *Geschäftsgruppe*), consists of First, Second, and Third Subdivisions, and is charged with the personnel.

First Subdivision, having a commander in charge and three lieutenants as assistants, has charge of the officer personnel.

Second Subdivision, in charge of a commander, with a lieutenant as assistant, has charge of the enlisted force.

The third Subdivision has only paymasters attached to it, and deals only with the administrative business of the Bureau.

A captain is in charge of the Bureau. The group of offices might be called a Bureau of *Personnel*, and has charge of all matters relating to the personnel except such as come under the Private Cabinet, enumerated above.

Second Bureau (2. *Geschäftsgruppe*) is in charge of a captain, and consists of fourth, fifth, and sixth Subdivisions. Its duties are in connection with material.

Fourth Subdivision: Chief, a commander; assistants, one chief engineer, second class, and one engineer, first class, of naval construction; one chief engineer, second class, of machine construction; one chief engineer and one engineer, second class, of marine artillery. Under this Subdivision come naval construction, machinery, and ordnance.

Fifth Subdivision: Chief, a colonel of engineers; assistants, two paymasters. Buildings, hydraulic works, etc.

Sixth Subdivision is in charge of a paymaster with relative rank of captain; assistants, two paymasters charged with administrative affairs of the Bureau, except those of the Fifth Subdivision.

Seventh Subdivision is the Judge-Advocate's Office, and is in charge of an officer ranking with colonel.

Eighth Subdivision is in charge of the Paymaster-General of the Navy with relative rank of rear-admiral, and is the Accountant and Disbursing Office for the Marine Section. There are six paymasters as assistants.

All these offices are at Vienna. A very important part of the organization is the Technical Committee, whose office is at Pola. Its duties are to study all questions of a marine technical nature, such as ship-building, machinery, ordnance, torpedoes, etc., to conduct experiments and make researches and report results of their investigations to the Chief of the Marine Section at Vienna, to advise and make suggestions. The president is a rear-admiral, the vice-president a captain. There are seven subcommittees, as follows:

(1) Ship-building: The senior engineer of naval construction and three other engineers of that branch.

(2) Machinery: The senior engineer of machine construction and three other engineers of that branch.

(3) Artillery: Two naval lieutenants, four marine artillery engineers.

(4) Torpedoes: One commander, one lieutenant-commander, two lieutenants, one sublieutenant, one marine artillery engineer, one engineer machine construction, two mechanicians.

(5) Mines: One commander and two lieutenants.

(6) Technology and Electricity: The Chief Marine Electrician, one lieutenant, and one engineer of machine construction.

(7) Hydrography and Navigation: One commander and three lieutenants.

The members of the subcommittees are experts in their several branches. In addition to the above officers on the Committee, are one lieutenant and two sublieutenants as aides to the president.

The Medical Direction is also at Pola. The chief is the senior medical officer of the navy with relative rank of captain. His only assistant has the relative rank of commander.

Note for Page 308.

By an Imperial decree, too recently promulgated to make the alterations in the following table, the numbers allowed in the different grades in the Austrian Navy have been slightly changed. The *Admiral Stabs-Arzt* has now the relative rank of *Contre-Admiral*, and the *Ober-Stabs-Aerzte* have been divided into two classes, the first class having the relative rank of *Linienschiffs-Capitan*, second class that of *Fregatten-Capitan*.

Seeöfficiere (Officers of Military or Executive Branch.)	Marine-Geistlicher (Chaplains.)	Marine-Aerzte (Surgeons).	"Marine-Technische-Beamte" (technical civil branch).				Commissariat-Beamte (paymaster).
			Schiffbau (Constructors, ships).	Maschinenbau und Betrieb (Machine building).	Marine-Artillerie (Marine artillery).	Maschinisten (mechanical engineer) in charge of machinery in sea-going ships.	
1 Admiral.							
2 Vice-admirale.							
6 Contre-admirale	......	......	......	......	......	......	1 General-Commissär (paymaster-general).
18 Linienschiffs-Capitäne (Captains).	......	1 Admiral-Stabs-Arzt (surgeon-general).	1 Oberster Ingenieur (engineer in chief)	(*) Oberster Ingenieur	1 Oberster Ingenieur	......	3 Ober-Commissäre, 1. classe (chief paymaster).
21 Fregatten-Capitäne (Commanders).	......	3 Ober-Stabs-Aerzte (surgeons).	2 Ober-Ingenieure, 1. Classe (chief engineer).	2 Ober-Ingenieure, 1 Classe.	2 Ober-Ingenieure, 1. Classe.	......	4 Ober-Commissäre, 2. Classe.
28 Corvetten-Capitäne (Lieutenant-commanders).	1 "Pfarrer" (chaplain).	4 Marine-Stabs-Aerzte (surgeons).	2 Ober-Ingenieure, 2. Classe. 3 Ober-Ingenieure, 3. Classe.	2 Ober-Ingenieure, 2. Classe. 3 Ober-Ingenieure, 3. Classe.	2 Ober-Ingenieure, 2. Classe. 2 Ober-Ingenieure, 3. Classe.	1 Ober-Maschinist (chief mechanical engineer).	12 Commissär (paymaster.
107 Linienschiffs-Lieutenante 1. Classe (Lieutenants, first class).	4 Chaplains, first class.	18 Linienschiffsärzte (assistant surgeons).	8 Ingenieure, 1. Classe.	7 Ingenieure, 1. Classe.	3 Ingenieure, 1. Classe.	12 Maschinisten, 1. classe (mechanical engineer).	40 Commissär-Adjuncten, first class.
54 Linienschiffs-Lieutenants 2. Classe (Lieutenants, second class).	3 Chaplains, second class.	17 Fregattenärzte (assistant surgeons).	5 Ingenieure, 2. Classe.	5 Ingenieure, 2. Classe.	6 Ingenieure, 2. Classe	35 Maschinisten, 2. Classe	41 Commissär-Adjuncen 2. classe 3.
161 Linienschiffs-Fahnriche (Sublieutenants).	......	14 Corvettenärzte (assistant surgeons).	10 Ingenieure, 3. Classe.	9 Ingenieure, 3. Classe.	3 Ingenieure, 3. Classe	42 Maschinisten, 3. Classe	35 Commissär-Adjuncen, 3. Classe.
121 Seecadetten 1. und 2. Classe (Sea cadets, first and second class).	......	......	5 Eleven (pupils); no relative rank.	12 Eleven (pupils); no rank.	4 Eleven (pupils); no relative rank.	......	21 Eleven (pupils); no relative rank.
9 Seeaspiranten (Sea aspirants).							

In addition to the above there are 8 judges-advocate, with military titles from lieutenant to lieutenant-colonel; 5 civil engineers, with relative rank of sublieutenant to commander; 1 electrician, with relative rank of commander and 1 with relative rank of lieutenant. Employés or officials in hydrographic office: 1 ranking with captain, 3 with commander, and 1 with lieutenant-commander.

*Vacant.

Officers of the military and executive branch are educated at the Naval Academy. The course is four years, after which the graduates serve for two years on board of regular cruising vessels of the navy as second class Sea Cadets. At the expiration of this time, if they pass the required examination, they are promoted to first class Sea Cadets, and later on, as vacancies occur, they are promoted to the grade of sublieutenant without further examination.

In the appointment of cadets to the academy, by the Chief of the Marine Section of the Ministry for War, preference is given in the following order: (*a*) To sons of naval officers, of army officers, of officers of both *Land-Wehren* (reserves); (*b*) sons of the officers of the civil branch (*Beamten*) of the navy, army, and reserves; (*c*) sons of court officers and civilian officials; (*d*) candidates having residence on the sea-coast.

The Government bears the entire expenses of the education of a portion of the cadets, and these bind themselves to serve for a period of four years after graduation. Others are admitted each year who themselves pay half the expense of education (estimated at 400 florins a year), the Government bearing the other half. These must serve for two years after graduation. A certain number are permitted to pay the entire expense of their schooling, and agree to serve for one year after graduation. All are required to pass a physical and mental examination before being admitted to the academy.

Officers are sometimes taken from the *Seeaspiranten*, of which there are now nine on the list. This is not regularly done, but only occasionally. These aspirants are graduates of colleges or polytechnic schools between the ages of seventeen and nineteen, who have been selected after a competitive examination, and who have satisfied all the physical and other requirements as to family, etc. Being admitted, they are sent to Pola for a nine months' course in professional studies and practical exercises, after which they receive further instruction for three months on board of regular cruising vessels of the navy. At the end of this time, they have what is known as the cadet's examination. If this is passed with credit they may be admitted as sea cadets, second class, and their promotion goes on the same as that of the regular cadets from the Naval Academy.

There are no examinations for promotion after that to the grade of sea cadets (first class), and promotion takes place by seniority (in turn) in the line, but in the technical branches promotion is occasionally by selection.

Surgeons enter the navy from civil life as *Corvettanarzt.* They must not be over thirty-two years of age, and must have a doctor's degree of medicine and surgery from one of the universities of the country, be citizens, unmarried, know the German language, be of good health and character, and pass the examination. Preference is given to those who have had hospital practice.

Engineer branch enter from civil life.

Candidates for naval construction and artillery pupils must not be over twenty-four years of age; for machine construction and civil engineers, third class, not over thirty. The candidates must have a diploma from a technical high school, a perfect knowledge of German, must be citizens, and pass the technical and other examinations (among the latter being French and English), and be of good character. In addition, the candidate for naval construction branch must have had some practical experience either in naval or machine construction, and for machine construction and civil engineer branches at least two years' practical work in their branches. They enter as *Eleven* (pupils) in the naval construction and artillery branches and as engineers (third class) in the other branches, although occasionally pupils are admitted in the machine construction branch.

Mechanical engineers (*Maschinisten*). The entry into this branch is as machinist, third class. The requirements are robust health, not over thirty years of age; at least two years' successful practical work at trade as machinist, particularly in fitting, turning, and casting; at least one year's successful experience in running a locomotive-engine, or a river-boat engine, or that of an ocean-going steamer; satisfactorily pass the examination, which includes care and direction of steam-machinery, mechanical drawing, etc.; perfect knowledge of German; and to be a citizen. This class of officers is for service on board ship.

Paymasters enter as *Marine Commissariatseleven* (pupils or scholars). Requirements: Be between seventeen and twenty-four years of age, robust health, be a citizen, good character, perfect knowledge of German, be a graduate of a college, polytechnic school, or high military school, and pass the examination. Preference is given those who know several languages, such as Slavonian, Italian, English, and French.

Proportion of officers to ships.

1 flag officer to 6 ships.
1 commanding officer to a ship (about).
For executive, navigating, and watch officers' duties, 6 officers to each ship, and surplus of 14.
1 mechanical engineer to each ship, and a surplus of 3.
1 surgeon to each ship.
2 paymasters to each ship and a surplus of 12.

VIII.

ADMINISTRATION OF THE MERCHANT MARINE IN FOREIGN COUNTRIES.

By Ensign J. B. Bernadou, U. S. N.

If the development of a merchant marine be considered as a reason for the creation of a powerful and well equipped navy, matters that relate to the promotion of the welfare of seamen, and to the advancement of the interests of merchant shipping, possess a direct naval bearing. In the general management of the affairs of the mercantile fleets of foreign nations, and especially those of continental powers, two objects are kept constantly in view; increase of commerce and rapid recruiting for the naval service in times of need of large bodies of seamen. How these ends are considered in different countries to be most efficiently accomplished an examination of the various systems of control of mercantile affairs will aid in showing.

With a view of facilitating comparative study, the following brief sketches of systems at present in operation in England, France, Germany and Italy have been prepared. They contain: (1) enumerations of duties to be performed by the officers of the various services; (2) accounts of organizations of personnel and distributions of work among officers and offices; (3) brief mentions of the laws and regulations in accordance with whose provisions the control is maintained. The sole object being to illustrate the various methods of management of affairs that in their inherent nature are pretty much the same in all countries, explanations of specific relations have been avoided, except in cases where such are of aid in throwing light upon the duties of the various officers of the maritime services. The material of which the papers are composed has been supplied in the main by the books of laws and regulations deposited in the libraries of the State and Navy Departments and the Office of Naval Intelligence. Inasmuch as new mercantile laws are occasionally enacted, while old ones are not unfrequently amended, it is difficult to obtain an assurance that matter quoted is, in all cases, up to date. It is hoped, however, that what is given will serve to illustrate the working methods of the various systems described.

ENGLAND.

The general management of the affairs of the mercantile marine of England is intrusted to an administrative body known as the Board of Trade. The present system of control, which represents a radical change in British commercial policy, was established in 1854 under the provisions of the Merchant Shipping Act of that year, and still remains in full force, although the original act has been gradually amended, so as to provide for recent special needs, and to meet such emergencies as have arisen from time to time.

The subjects of which the Board of Trade takes cognizance, directly or indirectly, are found embodied in the "Digest of Statutes relating to Merchant Shipping," a work based upon the Merchant Shipping Act, presenting the original act in sections to which the relative provisions of amendments and of subsequent acts are appended.

These subjects may be summarized under the headings of the Digest, as follows:

(1) *British ships; their ownership, measurement, and registry.*—The determination of what constitutes British ownership in accordance with the provisions of the act; the tonnage measurement of vessels in accordance with the prescribed rules; the appointment of registrars in the United Kingdom and in the colonies thereof; the provisions for registry; the proper execution of sales, transfers and mortgages of shipping and the revocation of mortgages.

(2) *Provisions relating to masters and seamen.*—The holding of examinations and issuing of certificates to masters of vessels, mates and engineers; the assisting of boards of guardians, overseers and persons desirous of apprenticing boys for sea-service in making apprenticeships; the granting of licenses to persons engaged in supplying seamen to merchant ships; the enforcement of the measures of the act relating to allotment, payment of wages and discharge; the supervision and control of funds for the pensioning of seamen and the distribution of pensions under the provisions of the act; the establishment of seamen's savings banks and the framing of regulations for their conduct; the proper distribution of the wages and effects of deceased seamen; the bringing home of distressed seamen and measures for their relief; the general supervision of matters relating to food, health and accommodations, and the enforcing of the laws relating to spacing (number of cubic feet for each man); the protection of seamen from imposition ashore and afloat and the enforcement of measures relating thereto; the investigation of cases of incompetency of masters, mates and engineers, and the suspending and cancelling of certificates; the maintenance of a general system of registration of seamen; the establishment of forms for logs and the enforcement of regulations in relation to the same.

(3) *Safety and the prevention of accidents.*—The survey of ships reported as unseaworthy; the inspection of the boats of sea-going ships; the enforcement of the special laws relating to the manufacture and testing of chain cables; the printing and distribution of all regulations relating to ships' lights and to the prevention of collisions at sea; the enforcement of regulations for the proper building of steamships; the appointment of surveyors for steamships; the establishment of fees for this service; the regulation of methods of survey and the issuing of certificates relating thereto; the superintendence of the emigration of the poorer classes to the colonies, and the enforcement of the regulations in regard to the proper carriage of emigrants.

(4) *Pilotage.*—The general supervision of all matters relating to pilotage, under the various authorities to whom the care of the same is entrusted; the receipt of returns and information relating thereto and their transmission to Parliament; the withdrawal of pilotage certificates and the provisional granting of the same.

(5) *Light-houses.*—The general supervision of the affairs of lights and light-houses, controlled by corporations known as Trinity House, Commissioners of Northern Light-houses, and the Commissioners of Irish Lights.

(6) *Mercantile Marine Fund.*—The control of a fund known as the Mercantile Marine Fund, made up of fees paid into the board under the provisions of this act and of fees paid to light and pilotage authorities, and from which are paid the salaries of officers, expenses of maintenance of life-saving and light-house services, expenses incurred in the care of buoys and beacons and the preservation of property, and the incidental expenses of the board.

(7) *Wrecks, casualties and salvage.*—The superintendence of matters relating to wrecks, the appointment of receivers, and the establishment of fees to be paid to the same.

The provisions of the Merchant Shipping Act are enforced by the Board of Trade through the medium of an administrative organization that may be outlined into principal divisions as follows:

1. THE MEMBERS OF THE BOARD OF TRADE.—The chief officer of the board is a president, who is assisted by a parliamentary secretary by whom business is transmitted to Parliament. There is a permanent and an assistant secretary for each of the main departments into which the board is divided. The duties of these departments are summarized as follows:

(1) *Marine Department.*—Matters relating to Admiralty Courts; Chain-Cable and Anchor Act; crew spaces; discipline; relief of distressed seamen (system of procedure); examination of masters, mates and engineers; international code of signals; international questions concerning shipping; life-saving apparatus; lights and fog-signals; medicine and antiscorbutics; mercantile marine offices and local marine

boards; misconduct, inquiries into; naval reserve; passenger ships, survey of; rewards for saving life; measurement of tonnage; training ships; unseaworthy ships; wrecks and casualties, inquiries into; wreck register.

(2) *Finance Department.*—Accounts and estimates of all departments of the Board of Trade; accounts of light-house boards; accounts of consuls and colonial shipping masters, including accounts of relief of distressed seamen and of superintendents and receivers of wreck; claims of owners of vessels; life assurance companies' returns; merchant seamen's fund; seamen's saving and temporary deposit banks; wages and effects of distressed seamen.

(3) *Harbor Department.*—Average; Explosive Act (regulating carriage of explosives); fisheries; freights; harbors; liabilities of shipowners; light-houses and fog-signals; loans to harbor authorities; local charges on shipping; pilotage; protection of navigable channels; provisional orders in relation to piers and harbors; provisional orders in relation to oyster and mussel fisheries; quarantine; registration of ships; standards; matters relating to Suez Canal; tidal waters; wreck and salvage.

(4) *Railway Department.*—Matters not related to merchant marine.

(5) *Statistical Department.*—Statistics in general.

2. LOCAL MARINE BOARDS.—These are organizations for carrying into effect the provisions of the Merchant Shipping Act, under the superintendence of the Board of Trade, at the sea-ports of the United Kingdom. Their members are appointed in part by the Board of Trade from among the local magistrates and residents of the districts and are in part elected by the owners of foreign-going ships and of home-trading passenger ships registered at the port. These boards also appoint examiners for candidates for masters, mates and engineers.

3. MERCANTILE MARINE OFFICES.—These are established in three ways: (1) By local marine boards; (2) at custom-houses where their management is intrusted to officers of customs; (3) independently by the Board of Trade. Their affairs are administered by superintendents, whose general duties are:

> To superintend the engagement and discharge of seamen and to explain the laws relating thereto; to give assistance in securing the attendance on board at the proper times of men who are engaged; to facilitate the making of apprenticeships to the sea service; and to register, and indorse such registry upon, all indentures, assignments, or cancellation of indentures presented to him for that purpose.
>
> To act as the channel through which attested copies of documents deposited in the general register and record office of seamen (office of Registrar General) will reach persons at the outports, and to assist owners of ships in convicting defaulters or deserters by adducing the necessary evidence; to render an account of the receipt and payment of public moneys in such form and at such periods as the Board of Trade may direct.

The more important duties of the Mercantile Marine Offices,—the attestation and explanation of the agreement, the settlement of disputes concerning wages, the inquiry concerning deaths which have happened on board, the scrutiny respecting the wages and effects of deceased seamen, or respecting seamen left sick aboard—are to be discharged by the superintendent himself or by some properly appointed person.

4. THE OFFICE OF THE REGISTRAR GENERAL OF SHIPPING AND SEAMEN—where are kept the general records relating to those mercantile matters over which the Board of Trade exercises a supervision. The principal duties of the Registrar General are: the keeping of a list of all seamen; the registration of all documents relating to shipping forwarded to the central office by shipping masters, customs officers and registrars; the recording of grants, cancellations and suspensions of certificates of service and competency, and the recording of indentures of apprenticeship.

5. Registrars of shipping at ports of the United Kingdom and colonies; officers to superintend the treatment of emigrants and passengers afloat; inspectors to report upon accidents in accordance with the provisions of the act; persons to make inquiries in relation to wrecks and casualities, and assessors, nautical and engineering, to assist them.

As noteworthy features of the system may be mentioned:

(1) The nominal character of the relations with the naval reserve. The act for the provision and maintenance of a reserve (Reserve Volunteer Force of Seamen Act), places the powers for the maintaining of the same in the hands of the Lord High Admiral or the commissioners representing him. But one section of this measure would seem to enjoin duties upon the officers of the merchant marine—that by which every shipping master is enjoined "to give all assistance in his power towards carrying out the requirements of the reserve act, in such manner as the Commissioners of the Admiralty shall direct."

(2) The existence of older bodies and corporations controlling pilotage, lights and buoys, and light-house service, whose powers are acknowledged by the act, but whose ultimate suppression would seem to be aimed at.

The magnitude of British commerce and navigation movement has gained for the administrative control of their affairs a place of greater importance than is accorded thereto under the administrative systems of other countries. In this connection Lieutenant Calkins, in a paper upon the mercantile marine of England, appended to the report of the Secretary of the Navy for the year 1882, says:

> It is necessary to point out that the Board of Trade is a misleading title. The head of this department is a cabinet minister and his control over affairs is as complete as that exercised by the head of any other department. The connection of a committee of the privy council with its affairs has long been obsolete. The President of the Board of Trade is virtually Minister of Commerce.

FRANCE.

From the days of Colbert to the present time, one principle, the right of the state to require service of the individual, has influenced legislation relating to the navy and the merchant marine. The development of this principle has led to the establishment of the Maritime Inscription, a particular system of registry for all Frenchmen who follow the sea, upon which the recruiting for the naval service is based. Every person who is desirous of qualifying as a mariner is required to publicly signify his intention to this effect by having his name entered upon the Government rolls. By such entry he renders himself liable to a call for active service in the navy, and is deprived of a small fraction of his pay, which is withheld from him by the authorities and is covered into a special fund; in return he is guaranteed the exclusive right to pursue his calling under the national flag, and becomes entitled to a pension, either upon disability, or at the expiration of a stated period of active employment. Besides securing service for the navy, the Government thus becomes assured of the existence of a large body of trained men sailing under the national flag, who may be relied upon for service in time of war; and is put in the possession of accurate knowledge concerning the personnel of the merchant marine.

The laws relating to the merchant service have been enacted at various times during a period covering more than two hundred years. They are found embodied in the regulations entitled "*Règlement Géneral sur l'Administration des Quartiers, Sous-Quartiers et Syndicats Maritimes; l'Inscription Maritime; le Recrutement de la Flotte; la Police de la Navigation; et les Pêches Maritimes.*" The portion of the regulations that contains provisions possessing adirect administrative bearing may be summarized as follows:

Maritime Inscription.—The coasts of the Republic are divided into compartments (*arrondissements maritimes*), sub compartments (*sous arrondissements*), districts (*quartiers*) and syndicates. The officers in charge of districts shall bear the title of Commissary of Inscription (*Commissaire de l'Inscription Maritime*) and are paymasters in the navy.* In districts which contain one or more sub-districts the administration of the sub-districts is intrusted to delegates, who bear the title of Administrator of Inscription. The syndicates, which are the minor sub-divisions, are presided over by syndics, chosen from among the sea-faring population.

The general duties of commissaries and administrators of inscription are as follows:

(1) They are required to keep the rolls for the matriculation of seamen.

(2) They exercise the disciplinary powers conferred upon them by law in relation to infractions of the regulations.

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* See Chapter VII, p. 283.

(3) They receive orders in relation to the calling out of seamen for naval service, and see that the provisions of the same are executed.

(4) They keep a registry of the merchant vessels and fishing craft belonging to their districts, enter dates of equipment and putting out of service, and note the particulars of sales and shipwrecks and of the breaking up of old vessels.

(5) They inspect the crews of merchantmen and fishing craft and see that the provisions of the laws relating to the commands of these vessels and the composition of their crews are complied with. They require crews to be paid off in their presence, see that all passengers are properly accounted for, receive declarations of crimes committed at sea (to be referred to the proper legal authorities) and apprehend and punish deserters.

(6) They preside at the maritime commercial tribunals.*

(7) They attend to the proper distribution of the wages and effects of deceased seamen.

(8) They manage and distribute the funds of the maritime pensions.

(9) They render aid to vessels in case of stranding or shipwreck.

Similar duties in subordinate lines devolve upon the administrators of districts. The syndics, who preside over the syndicates, carry into execution the orders transmitted to them by the commissaries and administrators, and are required to keep themselves fully posted upon the movements of the seamen belonging to their syndicates.

The obligations imposed upon merchant vessels, their crews and their officers, are embodied in the regulations known as the "*Police de la Navigation*," and include relations with the inscription, the naval and the consular services, as well as with other services not directly connected with the marine.

Their provisions may be summarized as follows:

(1) *Relations with services not connected with the navy.*—Establishment of nationality; measurement; certificate of nationality; sailing license; obligations for the transportation of the mails.

(2) *Relations with maritime districts, the naval and the consular services.*—Enrollment of vessels upon district registers; special authorizations for the carriage of arms and ammunition; regulations concerning rations, etc. (measures for the protection of seamen); survey of ships; carriage of the national flag; crew lists and licenses; regulations governing captains of vessels in relations with crews; medical requirements; crews and their organization; apprentices; engagement of seamen and their pay; relations with naval and consular authorities; discipline of crews; disposal of effects of deceased seamen; lights, signals, communication by semaphore and the prevention of collision at sea; discharge of seamen in foreign ports and sending home of same.

The general superintendence over the affairs of the merchant marine is exercised by the Minister of Marine, who delegates the direct control of routine matters to the chief of a section of the Commissariat or Paymaster's Bureau of the Department of Marine (*Direction de la Compta-*

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* "Composed of merchants; competent courts in suits amounting to 1,500 francs in all controversies between merchants or relating to commerce."

bilité Générale). The duties of this section are summarized in the "*Annuaire de la Marine*," published under approval of the Department, as follows:

> *Direction de la Comptabilité Générale, sixth bureau; commercial navigation, fisheries, and the maritime domain.*
>
> General information relating to syndics; coast guards, captains of vessels and coast pilots; preparation of pilotage regulations; police of commercial navigation; maritime commercial tribunals; discharge of seamen in foreign ports and sending home of same; proper distribution of effects of deceased mariners and questions relating thereto; registration of vessels; allowances to schools for apprentices; rewards for saving life; police of coast fisheries and general provisions for the welfare of the same; reimbursements for losses of fishermen incurred under unusual circumstances; statistics of fisheries; establishment of limits of maritime compartments; decision of questions relating to the limits of the maritime domain.

The distribution of pensions and allowances is conducted by the Bureau of Naval Pensions and Allowances (*Établissement des Invalides de la Marine*). This bureau is also charged with the publishing of orders and keeping of accounts relating to pensions, and the collection of information concerning shipwrecks and maritime disasters.

The treasury of the *Invalides de la Marine*, which is under a separate management, is also controlled by the Navy Department. It is made up of three funds; the *Invalides* fund, properly so called, which is maintained by reserving a portion of the pay of all seamen in the naval and the merchant service; the fund for receiving amounts due absent seamen, and the prize fund.

It should be remembered that the maritime compartments into which the coast is divided serve not only as inscription districts, but also, and in a far more important sense, as divisions of the sea-coast for purposes of national defense. The naval and inscription authorities are separate and distinct. The relations between them are maintained by paymasters (*commissaires*), attached to the staffs of the department commanders, and the seamen drafted for service are turned over to the authorities at the naval centres.

All matters relating to customs are controlled by the Minister of Finance, who also signs the certificates of nationality issued to merchant vessels.

GERMANY.

The laws that regulate the affairs of the German merchant marine have been enacted at various times during the period intervening between the earlier confederation of the German States and the final incorporation of the same into the German Empire. The present laws, therefore, are characterized by imperial provisions of general import regulating all weightier matters, as well as by minor provisions of a very varied character that derive their origin from the earlier laws of the several independent state codes.

The constitution of the German Empire, promulgated in 1871, contains the following stipulation:

> The merchant vessels of all the confederated states are formed into one united merchant marine.
>
> The imperial government shall establish the method of determining the load-line capacity of ships, regulate the issuing of tonnage certificates and certificates of registry, and fix the conditions upon which the permission to employ vessels depend. The whole maritime population of the Empire, including all ships' machinists and shipwrights, are freed from service in the land army, and in lieu thereof are bound over to service in the imperial navy.

The central administration of the affairs of the merchant marine is assigned to the *Reichsamt des Innern*, one of the executive departments of the general government, controlled by the Chancellor of the Empire. The principal officers of this department with duties directly related to the control of the merchant marine are:

(1) The imperial commissioner for the superintendence of navigation.

(2) The members of the technical navigation committee (supervisors of ship-building).

(3) The commission for the superintendence of the examinations of masters of vessels, navigating officers, and ships' engineers.

(4) The general inspector for the measurement of vessels.

(5) The director of the *Seewarte* (meteorological and signal service).

The immediate control within the limits of the Empire of all matters relating to shipping and seamen other than such as are connected with the naval service and the customs devolves upon a number of classes of officers appointed in various ways, and over whose duties the imperial government exercises a supervision. These may be enumerated as follows:

(1) *Commissioners for the examinations of captains and navigators of merchant vessels.*—Examinations are of two classes: (*a*) for captain of vessels engaged in coast voyaging in the seas bordering Europe; (*b*) for captain and navigator of vessels engaged in trans-oceanic voyages. For class *a* the commission consists of three members—a president, appointed with sanction of the general government, a navigation instructor from the public navigation schools, and a nautical expert. For class *b* the commission consists of five members—a president, appointed with the sanction of the general government, two instructors from the public navigation schools, and two nautical experts.

(2) *Commissions for the examinations of engineers for sea-going vessels.*—There are three classes of examinations for the grades of engineer of the first, second, and third class respectively, differing in the nature of subjects in which the candidates are required to be proficient, as well as in the amount of service required to be performed ashore in shops and afloat in sea-going steamers. The commission consists of three members—a president, an engineer who holds a certificate as engineer of the first class, and a navigation instructor or instructor in mathematics.

(3) Officers charged with the issuing of certificates of qualification

to masters, navigators, and engineers, and with the proper recording of such issues. They are assigned to the various coast districts of the confederated states of the Empire.

(4) As a branch of the public service closely connected with the affairs of the merchant marine may be mentioned the *Seewarte*, which is also under the control of the *Reichsamt des Innern.* It is charged with marine meteorological work, the collection of hydrographic matter of interest to mariners, the verification and correction of nautical instruments, and the care of marine observation stations. The personnel consists of a general director, four chiefs of divisions with the necessary assistants, a clerical force, and agents, coast observers, and persons in charge of stations.

(5) *The ships' registry authorities.*—The officers who, by virtue of the provisions of the Confederation law of 1867, concerning merchant shipping and the right to carry the Confederation flag, are appointed for the registry of vessels, administer the registry affairs of the various districts into which the coast is divided. Records are kept by them of the size, estimated tonnage, and place of building of vessels, the ports to which they belong, the names of owners, the right to German registry, etc.

(6) *Officers for the measurement and survey of vessels, and the issuing of certificates of measurement.*—Members of the staffs of the various customs and duty offices (*zollamt*) of the coast districts conduct and supervise the operations of measurement. The certificates are issued by officers of the various state governments, appointed with imperial sanction.

(7) *Shipping officers.*—In accordance with the provisions of the law of 1872, shipping officers for the seaports of the Empire are appointed under imperial supervision in the ways prescribed in the state laws, and are controlled by the superior state and district officials. They keep the official registers, in which are entered the names, ages, and places of residence of all seamen of their districts, as well as notes as to their fulfillment of required service in the navy. They issue to seamen "voyage books,"* which contain duly certified particulars as to their past service at sea, and which entitle them to recognition by the various consular and government authorities.

The shipping officers issue crew lists in accordance with prescribed forms. They settle, as far as may be within their power, such disputes as may arise between masters and crews in relation to agreements, and impose fines for infractions of the shipping regulations. The body of regulations entitled the "*Seemannsordnung*," issued in 1872, prescribe the requirements for entrance into the merchant service, the methods of enlistment and discharge of crews, the contracts to be entered into between masters and crews, the conditions of ships' discipline, and the fines and penalties to be imposed for infractions of the code.

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*Before an applicant receives his voyage book his military affairs must be in good condition. A pass is generally furnished by the district orderly sergeant (*bezirksfeldwebel*).

As is the case in other systems, the shipping officers afford aid and assistance to distressed seamen. In this relation the laws defining the duties of masters contain the following provisions:

> Every German merchant ship bound from a foreign port to a German harbor or to a port of Great Britain, the Sound, the Cattegat, or to a foreign harbor of the North Sea or Baltic, is under obligation to receive German seamen who are in distress abroad for return to Germany, upon the receipt of a written order from the shipping agent, and with the understanding of compensation.

(8) *Officers of the life-saving and wrecking services.*—Under an elaborately organized system of patrol the coasts of the Empire are divided into districts and sub-districts, whose affairs are managed by local officers under the supervision of higher officers of the state and departmental governments. Under this organization are administered the light-house, life-saving, and wrecking services and the patrol of the coast.

(9) *Authorities for the investigation of disaster at sea.*—There are twelve marine courts (*seeamt*) and one superior court (*oberamt*). The marine courts are State and not Imperial institutions. The ordaining and appointment of their supervising authorities devolves upon the State governments. The limits of their districts are determined by the *Bundesrath*, and the general supervision of their affairs is guaranteed to the Imperial Government.

As a special feature of the German system may be mentioned the recently established accident insurance for mariners, conducted under government supervision.

ITALY.

The affairs of the Italian merchant marine are administered in accordance with the provisions of the body of laws known as the "*Codice per la Marina Mercantile del Regno d' Italia.*" The system is outlined in the first division of the code as follows:

> The administration of the affairs of the merchant marine is controlled by the Minister of Marine, and comprises all that is attributed thereto by this code and that is or may be enjoined by law. The shores of the Kingdom are divided into compartments and these compartments are subdivided into districts. The number of compartments and districts, their limits, and the chief places thereof, are determined in accordance with a table annexed to the code. The administrative and technical service of the mercantile marine is performed by a corps of civil employés, of three grades, viz, captains of ports (*capitani di porto*), port officers (*ufficiali*), and port assistants (*applicati*). One-fourth of the posts under the category of port officers will be reserved for officers of the royal navy.
>
> In every chief place of a compartment a captain of port shall reside. In every chief place of a district other than that in which the captain of port is stationed a port officer shall reside. At other points of importance shall be stationed port officers subordinate to the officer at the chief place of the district. At places where no special officers are stationed the affairs of the merchant marine are to be managed by other government agents with similar powers, or by private individuals, called port delegates (*delegati*), with an annual salary fixed by law. The members of the corps of

officers, from the grade of assistant, shall be nominated by the King upon the proposal of the Minister of Marine. The officers of the mercantile marine service are designated as Port Officers, and shall be provided with aids, harbor watchmen, and seamen, in accordance with the provisions of the regulations. The administration of the affairs of the merchant marine in foreign countries is intrusted to consuls and consular agents.

The duties with which captains of port are intrusted are defined in the regulations entitled "*Regolamento per l' Esecuzione del Testo Unico del Codice per la Marina Mercantile*" (Regulations for the Execution of the Code for the Merchant Marine), and may be summarized as follows:

(1) They are encharged with the enrollment of mariners and the issuing of certificates of enrollment.

(2) They keep lists of persons engaged in maritime industries and issue permits.

(3) They provide for admission to examination of those who desire to qualify for grades in the merchant marine.

(4) They propose to the ministry of marine the issuing of certificates to persons found proficient in the examinations for the various grades of masters of vessels, marine engineers, and constructors, and they register and deliver the certificates.

(5) They issue certificates to those who qualify as mates and captains of small craft (*padrone*), to writers and to those who qualify as expert measurers, and licenses to captains of coasters and of vessels engaged in the high-sea fisheries.

(6) They keep a register of the pilots in the various maritime compartments and issue the necessary qualifying permits; they register the interpreters allowed at port offices.

(7) They attend to the proper distribution of the wages and effects of deceased seamen.

(8) They bring to the attention of the Minister of Marine meritorious actions performed at sea.

(9) They submit for the approval of the ministry of marine tariffs for lading and unlading of merchandise, embarcation of passengers, etc.

(10) They exercise the powers of arbitration and discipline conferred upon them by the mercantile marine code.

(11) They receive the shipping agreements of crews in conformity with the regulations.

(12) They are charged with the maritime inscription and the execution of the provisions of the laws relating thereto.

(13) They regulate and control the movements of small craft engaged in port and harbor traffic, ferriage, ballasting, etc.

(14) They keep a registry of the sale of steam and sailing vessels in the various compartments, and enter in accordance with prescribed forms all acts relating to ownership, transfers, mortgages, and the revocation of mortgages.

(15) They expedite the sale of ships under the provisions of the code relating thereto (forfeiture, war seizure, etc.).

(16) They propose to the ministry of marine the issuing and the renewal of certificates of nationality of vessels, and keep on file the documents upon which such issue is based.

(17) They keep a registry of vessels not furnished with certificates of nationality, and attend to the issuing of licenses to the same.

(18) They provide for the measurement of national ships and attend to the regularity of the operations.

(19) They provide for the survey of ships in accordance with regulation methods.

(20) They carry out the provisions of the law relating to shipwreck and salvage.

(21) They apply the anchorage dues and other fees, maritime and sanitary.

(22) They attend to the proper policing of shores and harbors, their proper maintenance, and the prevention of usurpations of government lands or deterioration of government property.

(23) They issue concessions for the private occupation of water areas, shores, and beaches.

(24) They enforce the harbor regulations.

(25) They render aid to vessels and crews in case of stranding or shipwreck.

(26) They exercise control in police matters over the naval dock-yards and other port establishments.

(27) They execute the laws and regulations concerning the fisheries, as far as the provisions concern them (issuing of licenses, control of navigation, and police of coast waters).

(28) They participate in the distribution of the marine pension funds, and co-operate in matters relating to the same in conformity to the laws relating thereto.

(29) They are responsible for the illumination of lights and beacons.

(30) They exercise a general superintendence over the affairs of their compartments.

Similar duties, in subordinate lines, devolve upon the port officers and their assistants.

By virtue of the provisions of a decree of November, 1889, the direct general superintendence of the affairs of the merchant marine is delegated to a civilian, who is entitled "Director General of Marine," and who is chief of a civil bureau of the Navy Department. The organization of this bureau, which constitutes the fourteenth, fifteenth, and sixteenth administrative sections of the Department, is given in detail in an appendix to the decree as a portion of the adopted system of administrative division of subjects, and may be outlined as follows:

GENERAL DIRECTION OF MERCHANT MARINE.

Fourteenth division.—FIRST SECTION: personnel of offices of captains of ports; division of coast into maritime compartments and classification of port offices; expenses and salaries; compensation to officers of ports and assistants; inspection of port offices.

SECOND SECTION: police of navigation; care of disabled mariners and sending home of destitute seamen; marine hospital funds; measurement and nationality of ships; pilotage; rates for landings of cargo, passengers, etc.; transfer charges.

THIRD SECTION: meritorious actions at sea and rewards for the same; proper disposal of effects of deceased mariners; collection of national and foreign publications relating to the merchant marine, and distribution of matter of value to mariners.

Fifteenth division.—FIRST SECTION: Examinations for grades; certificates; misdemeanors; arbitrations; fisheries; occupation of water areas for pisciculture; fishing stations; harbor works and relations with the Minister of Public Works in regard to the same; buoys; ballasting; licenses and concessions for employment at ports; lodging house taxes; store-ships and port ware-houses; damage to harbor works; removal of obstructions; moorings for small craft; salvage.

SECOND SECTION: concessions of beach lands for dock-yards, careening beaches, industrial establishments, and other uses; transfers of lands to Government; redisposal of usurped lands.

Sixteenth division.—Maritime taxes and shipping returns; statistics of navigation; annual report on progress and condition of the merchant marine; statistics of shipping and navigation.

It will be seen from the above that the Italian system closely resembles the French. For administrative purposes the coast is divided into a series of independent districts presided over by a corps of officers who are under the supervision of a central bureau, which is a section of the navy department. The district officers, whose duties are in the main of a non-military character, although possessing a distinct naval bearing, are in direct touch with the minister of marine in all matters connected with the naval reserve and the supply of seamen to the navy. The recruitings for naval purposes are based upon the provisions of a general maritime inscription, with the conduct of the affairs of which the mercantile marine officers are charged.

The marine pension fund, known as "*Cassi degli Invalidi della Marina Mercantile*," closely corresponds to the French "*Caisse des Invalides de la Marine*," and the methods of collection and distribution that are in force in the two countries are similar.

As special features of the Italian system may be noted the compact central administration of matters of national importance, the exhaustive system of examinations for masters and officers of vessels, and the extension of the provisions of the mercantile marine code to the control of the affairs of all persons engaged in pursuits that are directly connected with the marine.

IX.

THE DEVELOPMENT OF RAPID-FIRE GUNS FOR NAVAL USE.

By Lieut. W. H. H. SOUTHERLAND, U. S. Navy.

The introduction of the rapid-fire gun was the outcome of an imperative necessity for adequate protection against the great offensive power which the torpedo had given to small vessels of high speed.

The danger from attack by the automobile fish torpedo, which can now be discharged with a reasonable degree of accuracy at ranges up to 400 yards and with chances of a lucky hit up to 800 yards, grew steadily with the gradually increasing speed of the torpedo-boat.

As the high-power guns could not be fired with sufficient accuracy and rapidity to give them even a moderate chance of destroying a swiftly moving torpedo-boat before it could get within the limits of danger to the ship, and as the small-bore machine-guns, which were primarily intended for the destruction of personnel only, were not effective against the modern torpedo-boat until it had approached near enough to discharge its deadly missiles, the extreme danger from these, even to the most heavily armored vessels, became so evident as to make it a source of anxiety to all naval powers.

Thus arose the necessity for a new weapon, the main object of which, as compared with the man-killing machine-gun, should be the rapid destruction of matériel at long ranges, and the principal characteristics as follows: Great accuracy when fired from an unsteady platform; continuity of fire; the power to project an explosive projectile with sufficient energy to penetrate and destroy the matériel of any torpedo-boat at long range; and the ability to follow a moving object from a moving platform.

Scarcely had this want made itself felt when it was apparently met by the introduction of the Hotchkiss 37-millimeter revolving cannon, which was adopted by the French Government in 1877 and soon afterwards came into use in the naval armaments of nearly all the principal maritime powers.

Two years later the Hotchkiss 47-millimeter revolving cannon appeared, and exhaustive competitive trials took place between it and various machine-guns, principally those of Nordenfeldt, to determine their relative efficiency as against torpedo-boats. England preferred the Nordenfeldt gun, but most of the other principal powers, including the United States, adopted the Hotchkiss revolving cannon.

In the mean time, however, torpedo-boats were developing greater speed, and the French, who have always recognized the vast possibilities of the torpedo and who have given more attention to the defense against it than any other nation, were not satisfied with the results obtained from the 47-millimeter revolving cannon, considering that it did not fulfill all the conditions mentioned above. Its muzzle velocity was less than 1,500 f. s., and the power of its projectile, though sufficient to penetrate, was not enough to cause destruction of matériel.

It was recognized that a larger calibre revolving cannon would necessitate so great an addition of weight as to render the resulting gun unsuitable for use on shipboard, but the need of a more powerful explosive projectile was deemed so urgent that the French department of marine artillery requested the Hotchkiss firm to construct a continuous fire gun that would give to the 47^{mm} shell a muzzle velocity of 1,800 f. s. No limitation was placed on the design, the idea being to preserve the accuracy of the revolving cannon and to increase its range, penetration, and power.

To meet this demand Mr. Hotchkiss designed a single-barrel 47^{mm} gun throwing a 2½-pound shell. It consisted of a tube with a square box screwed on its rear end, which box contained breech mechanism almost identical with that now used in the Hotchkiss type of rapid-fire guns. This gun was finished and successfully tried in Paris in 1880. The trial developed the fact that the breech arrangement could not withstand the high velocities possible, and Mr. Hotchkiss at once modified the design into that of the jacketed construction now in use.

In the meantime Mr. Nordenfeldt had been engaged in the construction of a somewhat similar design of a 6-pounder gun, which was experimented with in England with satisfactory results soon after the Paris trial of the Hotchkiss.

So far as we can learn the development of rapid-fire guns commenced in France and England at about the same time, but we believe that the idea originated with the French marine artillery officials, and that to Mr. Hotchkiss belongs the credit of its first practical application. Since that time a "rapid-fire gun" has been defined as one in which metallic cased ammunition is used with the projectile either in one with or separate from the charge; the withdrawal of the empty cartridge case is effected, in whole or in part, by a movement of the breech mechanism; the operation of loading is performed, entirely or in part, by hand; when recoil is permitted, the gun is returned to the firing position automatically.

Near the close of the year 1881 the English Admiralty issued to the ordnance firms of England an invitation to submit 6-pounder rapid-fire guns for competitive trials, subject to the following conditions:

1. To be a breech-loader with a range up to 4,000 yards.
2. To have a muzzle velocity of not less than 1,800 f. s.
3. To fire shell and steel shot of 6 pounds weight.
4. Projectile and charge to be in one for simultaneous loading.
5. Service of gun to be performed by three men.
6. To fire not less than twelve rounds a minute.
7. The mounting to be suitable for ship or boat, with an alternative for field service.
8. To be capable of delivering an all around fire.
9. The recoil to be reduced to lowest limit and gun to be returned to firing position after recoil.
10. To have a removable shield, proof against the Martini-Henry at 100 yards.
11. The total weight, including ship's mounting, not to exceed 10 cwt.

At about the same time the French Government issued a somewhat similar invitation for competitive trials of 3-pounders, stipulating certain requisites, the principal ones of which were as follows:

1. An initial velocity of 1,900 f. s.
2. To fire a steel armor piercing projectile capable of piercing ⅝-inch steel plates at an angle of 30 degrees to the normal at a distance of 2,624.7 yards.
3. The ability to fire twelve aimed, or twenty-five unaimed shots a minute.

The Hotchkiss firm only responded to the French invitation, and, after exhaustive tests, during which a muzzle velocity of 2,002 f. s. with a chamber pressure of but 14.2 tons to the square inch were obtained, their 3-pounder gun was adopted for the French naval service. In this test a shell perforated a ⅝-inch steel plate at an angle of 30 degrees to the normal at a range of over 4,300 yards.

Armstrong and Nordenfeldt accepted the English invitation at once, and soon after the English Admiralty granted the request of the Hotchkiss firm to submit a 6-pounder in competition.

The trials of these three types took place at Shoeburyness during the latter part of 1883, and none of the guns presented completely fulfilled the conditions imposed, as set forth above. The Armstrong gun, which was of a design entirely different from that of the present Armstrong type, broke down at the commencement of the trials and had to be withdrawn.

The following are believed to have been the principal details of the remaining guns:

	Hotchkiss.	Nordenfeldt.
Total weight of gun .... cwt..	8.6	4.4
Weight of powder charge .... ounces..	31¼	29
Weight of projectile .... pounds .	6	6
Muzzle velocity obtained .... f.s..	1,869	1,870

These guns were very similar in appearance and differed but in few particulars. The breech-wedge of the Hotchkiss was in one piece, while that of the Nordenfeldt was in two. The former was capable of almost instantaneous pointing by means of a shoulder-piece, while the latter was pointed a little more slowly by means of screw gearing manipulated by two hand-wheels. The former was mounted on a non-recoil elastic frame stand, and the latter was mounted for a short recoil. It was found during the trials that no non-recoil mount could withstand the strain of the greater recoil energies of the lighter Nordenfeldt gun. Both guns proved completely successful as far as mechanical development was concerned, but the ordnance authorities were better satisfied with the Hotchkiss, as was evidenced by the resulting order for a number of guns for the naval service—two-thirds to be furnished by the Hotchkiss firm and one-third by Nordenfeldt.

In the early part of 1884, before either England or France had given any order for guns of this system, the United States Navy Department, without having had any previous trials, cabled an order to the Hotchkiss firm for a number of them to form part of the armaments of the *Atlanta*, *Boston*, *Chicago*, and *Dolphin*, and this order was the first ever given by any Government for rapid-fire guns for actual service.

In 1885 the Hotchkiss firm made arrangements with Sir William Armstrong to carry on the manufacture of their guns in England, and up to the end of that year all competition in and development of rapid-fire guns, was confined to the two original makers, Nordenfeldt and Hotchkiss. Then others entered the field, and since that time the following additional types have appeared, viz: Armstrong, Krupp, Driggs Schroeder, Gruson, Maxim, Thronson, Engström, Canet, Daudeteau, and Skoda.

Speaking generally, the principal differences in these types are those pertaining to the details of breech mechanism. The form of breech-closure in each is either that of a sliding-wedge or of an interrupted screw, and in all the longitudinal strains are taken by the jacket instead of by the tube.

A non-recoil mount was in general use at first, but the recoil energies of these high-velocity guns, even when as small as a 3-pounder, have been found to bring too great a strain on the mounts and fittings, and it is only a question of time when all calibres of guns of this system will adopt recoil mounts. In our own naval service all rapid-fire guns, from the 1-pounder up, are to hereafter have some recoil. Not only will this greatly reduce the strain on the mounts and fittings, but it will also improve their ballistic qualities.

As the benefits to be gained from the accuracy, rapidity, and power of the guns of this system became evident from practical tests of the 3 and 6 pounders, it was seen that their sphere of utility admitted of extension, and larger calibres of greater power were constructed, in which, of necessity, a greater recoil had to be allowed, which meant a corresponding loss of rapidity in firing. But before any of these larger guns were ready for use special recoil checking arrangements with an automatic return to firing position were introduced, by means of which the loss of time from running out and relaying the gun after firing was reduced to a minimum.

Of these larger guns, which may properly be classed as armor-piercing, we will treat hereafter, confining ourselves for the present to the smaller calibres, which may appropriately be termed anti-torpedo guns.

In order to cope successfully with a swiftly advancing torpedo-boat, a gun must be capable of giving for a short period of time a rapid and continuous fire of explosive projectiles having great penetrative power up to a range of about 2,000 yards, and of such quick and accurate training as to admit of being kept constantly bearing on the advancing boat.

The 3-pounder and 6-pounder approximate so nearly to these essentials, as well as to the additional ones of lightness and general handiness, as to cause them to be looked upon as ideal anti torpedo guns. This statement is justified by the results of many experiments, to but few of which reference is necessary.

One, carried out in France with the Hotchkiss 3-pounder, was at a range of 765 yards against a target representing the bow, the five following transverse bulk-heads, and the front shell of the boiler of a first-class torpedo-boat. The projectile, a loaded steel shell, perforated the bow-plate and exploded just before reaching the first bulk-head, the fragments of the shell keeping on and doing damage as follows: One large and one small hole and a few dents in the first bulk-head; twenty-one holes and twelve dents in the second bulk-head; nine holes and five dents in the third bulk-head; twelve holes and nine dents in the fourth bulk-head; two holes and two dents in the fifth bulk-head; and one hole and one dent in the shell of the boiler.

In another trial at the same target, but at a distance of 1,860 yards, an unloaded steel shell perforated all the plates and struck the ground about 1,100 yards to the rear of the target.

The following table contains only the principal details and ballistics of the 3-pounders now adopted for use in the navies of either England, France, or the United States:

	Nordenfeldt.	Driggs-Schrœder.	Hotchkiss.
Calibre ......in..	1.85	1.85	1.85
Total weight ......lbs..	476	497	507
Length of bore ......cal..	.45	.44	.40
Weight of charge ......oz..	29.9	27.53	27.53
Weight of projectile ......lbs..	3.3	3.3	3.3
Weight of complete cartridge ......do...	6.5	6.37	6.37
Length of complete cartridge ......in..	20.1	20.1	20.1
Muzzle velocity, ordinary powder ......f.s.	1919	2048	2002
Calculated penetration in steel at—			
Muzzle ......in..	3.00	3.28	3.17
1,000 yards ......do..	1.65	1.94	1.83
2,000 do ......do..	1.00	1.26	1.16
Rapidity of aimed fire per minute ......about..	14	14	14

We will not consider the Maxim rapid-fire gun in this article, as it has not been adopted as a service weapon by any naval power. Its details, with the exception of the breech mechanism, are identical with those of the Nordenfeldt gun, and it can be fired either automatically or at will. Loading by hand and firing automatically, it has in practice attained a rate of over 40 unaimed shots a minute.

In all these types the longitudinal strains are taken by the jackets. Careful tests of most of them have shown the simplicity, and proved the strength, endurance, and safety of the breech mechanism, the cartridge-case ejectors, and the firing apparatus. The breech mechanism of the Driggs-Schrœder possesses an advantage in the matter of weight.

The maximum rate of fire does not vary much, but this is a factor which counts for but little. Aimed fire is the only true measure of value, for in the practical use of these guns the first consideration will be to obtain the maximum result from each shot, and this can not be accomplished by simply blazing away without taking aim. In all these guns the breech-wedge can be completely opened and closed nearly sixty times a minute, but when it comes to introducing a cartridge each time all will have about the same rate of fire for aimed shots, and with the 3-pounder we do not think it will exceed fourteen per minute.

In order to demonstrate the relative efficiency of these guns for defense against torpedo-boats as compared with that of high-power guns, we will suppose an extreme case—one that would not be at all likely to occur under ordinary conditions—that of an attack on a cruiser similar in design and armament to the *Baltimore*, by a torpedo-boat of the type of the *Cushing*, and will consider that fire is opened on the latter when at a distance of 1,500 yards—about three-fourths of a nautical mile.

To obtain the full value of the high-power guns, we will also consider that the attack is made from abeam, in which case the cruiser would use two 8-inch B. L. R., three 6-inch B. L. R., two 6-pounder Hotchkiss rapid-fire guns, and one 3-pounder Hotchkiss rapid-fire gun. The torpedo-boat would probably not be able to discharge her torpedo with accuracy beyond 400 yards, and to get within that range she would have to traverse, under fire, a distance of 1,100 yards, which, at a speed of 22 knots (about 37 feet per second), would take 1 minute 29 seconds.

During such interval, under the most favorable circumstances, it is just barely possible that the 8-inch guns would get in two shots each, or four in all, and the 6-inch guns, three shots each, or nine in all; a total for the high-power guns of thirteen shots. During this same time, however, the rapid-fire guns would easily get in twenty aimed shots each, or a total of sixty shots for the three of them. One alone would get in 50 per cent. more aimed shots than could be fired from all five of the high-power guns, and about seven times as many as could be fired from any one of the high-power guns.

But the superiority of the rapid-fire gun for defense against torpedo-boat attacks is not only in the number of aimed shots. With the rapid and continuous change of position of the torpedo-boat the difficulty experienced in getting accurate aim with the high-power guns would be very great, as they are not capable of quick loading and training, and good shooting, especially at so small a target as is presented by this torpedo-boat, requires pointing the gun with great care and skill. This, in addition to the unsteadiness of the gun platform, would give to the torpedo-boat a fair chance of avoiding the shots from the high-power guns.

These objections can not be urged against the rapid-fire guns, for right here comes in one of the greatest of their many advantages for this character of work—the ability to be rapidly and accurately trained from a moving platform upon a moving object. Being practically non-recoiling, the necessity for relaying the gun is obviated, and the use of fixed ammunition permits the maximum rapidity of loading and firing.

An expert marksman should be able to keep his rapid-fire gun constantly trained on the torpedo-boat, which, bows on, presents a target $5\frac{2}{3}$ feet high by 15 feet wide. It takes three and two-third seconds to run her own length of 138 feet, or about two seconds to run the length taken up by her vital parts—engines, boilers, conning tower, and torpedo outfit.

As soon as the point of impact of the projectile indicates to the gun captain that he has the correct range he can fire his gun at its maximum rate for this two seconds, plus the length of time taken by the boat in traversing her danger zone. Let us suppose that this does not happen until the torpedo-boat has reached a point 800 yards distant from the cruiser, at which range the danger zone would be about 140 yards, a distance that the torpedo-boat would take 11.3 seconds to traverse, thus allowing a maximum rapidity of fire for 13.3 seconds, during which time each gun could easily fire six shots—a total of eighteen shots for the three.

The rectangle passed over by the torpedo-boat during this interval of time is greater than that upon which these rapid-fire guns, on the proving ground (where, however, the circumstances are all most favorable to good shooting), will put in all of any number of shots fired. Making the very liberal allowance of 50 per cent. for all the disadvantages incident to firing at a moving object from an unsteady platform, we will have one-half the shots hit the torpedo-boat—a total of nine shots from the three guns during this 13.3 seconds only.

If the impact of the shot could not be seen, or if during a night attack, the same result would be obtained if the three guns had been originally sighted for 800 yards and kept constantly trained on the advancing torpedo-boat. Of course, we do not intend to intimate that in an actual night attack the three guns would all be sighted for the same distance.

We do not believe that a single torpedo-boat would ever make a day attack under such circumstances as those referred to above, and have only taken such an example in order to demonstrate the great efficiency of these rapid-fire guns for defense against torpedo-boat attacks.

The range of efficiency of these smaller calibres does not end here. Torpedo-boats armed with torpedoes only will be in no condition to resist attacks from an enemy's torpedo-boats, and they will need some means of defense. On the score of lightness, general handiness, and weight of ammunition supply, the 1-pounder and 3-pounder commend themselves for this purpose. So mounted, in a night attack, a lucky shot might silence an only opposing rapid-fire gun, or, by disabling the enemy's search-light, render possible the discharge of a torpedo in the ensuing darkness.

These guns will also be able to do excellent work against unarmored cruisers and the unprotected parts of armored vessels. The 6-pounder will perforate 2-inch gun shields, under ordinary service conditions, at ranges up to 1,000 yards, and will perforate the sides and sweep the decks of vessels like the *Chicago*, *Boston*, and *Atlanta* at a distance of over 2 miles, being capable, at closer ranges, of so damaging the long protruding chases of the high-power guns as to render them unfit for use. With the coming use of smokeless powders, the velocities, ranges, and penetrations here considered will be much increased.

As the benefits to be gained from the power, and the rapidity and continuity of fire from these guns became more and more evident their sphere of utility was extended until the system was finally applied to guns which may fairly be classed as armor-piercing. The largest one of these guns constructed up to the present time, and in actual use on board ship, is the Armstrong 6-inch, which, on proof trial, fired six shots in one minute.

There is a limit, however, to the use of fixed ammunition in rapid-fire guns due to its increase in weight and length, and, within that limit, the combined weight of the charge, projectile, and cartridge-case should be such that one man could handle it with ease and rapidity, and could readily exert sufficient power to extract the empty cartridge-case after firing. To our mind that limit is reached with a weight not exceeding 60 pounds, which is nearly that proposed for guns of about 4-inch calibre.

The following table contains some details and ballastics of the highest calibres of these guns now constructed, in which fixed ammunition can be readily handled by one man:

	Canet.	Hotchkiss.	Krupp.	United States Navy.
Calibre ins.	3.94	3.94	4.13	4.00
Weight tons.	2.1	1.7	1.3	1.5
Length of bore cals.	45	42	35	40
Weight of charge lbs.	14.3	13.2	8.6	12.5
Kind of powder to be used	Smokeless.	Prismatic.	Prismatic.	Prismatic.
Weight of projectile lbs.	28.7	33	39.7	30
Estimated muzzle velocity f. s.	2,493	1,970	1,729	1,900
Muzzle penetration in steel ins.	9.1	7.1	6.5	7.1
Aimed shots per minute about.	6	6	6	6

The complete cartridge used with the Hotchkiss gun here referred to is 3 feet 5.5 inches in length and weighs 55.7 pounds. With charges of smokeless powder much smaller than those tabulated above, the Canet and Hotchkiss 3.94-inch guns have given muzzle velocities of 2,628 f. s. and 2,389 f. s., respectively, the former with a chamber pressure of 16.8 tons, and the latter 14.4 tons. The system has not ended with these guns, but has been still further extended, as will be seen from the following table of higher calibres thus far actually constructed:

Calibre.	Type.	Remarks.
4.724-inch...	Armstrong .	In use in English and Italian navies.
4.724-inch...	Canet.......	Constructed for Chilian navy.
5.12-inch....	Krupp	
5.91-inch....	Canet.......	Constructed for Chilian navy.
6.00-inch....	Armstrong .	In use in Italian navy. Adopted for use in English Navy.

One important change has been found necessary in these higher calibres of the Armstrong type, that of separating the charge and projectile, the combined weight of which and the great length when in the form of fixed ammunition having proved too much for one man to handle with ease and rapidity. It has also been found necessary to point by means of hand-wheels and gearing, as the momentum of such heavy masses proved to be too great to permit of fine pointing with rapidity by means of a shoulder-piece.

This separate powder charge is put up in a sealed metallic case, and, after firing, the empty cartridge case, instead of being entirely withdrawn at once, as in the smaller calibres, is first drawn out by the extractors but a short distance and afterwards pulled completely out by hand. The use of the charge and projectile separately naturally decreases the rapidity of fire, and also allows a greater degree of erosion by letting the products of explosion, at a maximum pressure, rush out between the projectile and the bore of the gun.

Notwithstanding these disadvantages, these two Armstrong guns have actually fired twelve and six unaimed shots, respectively, in one minute. As this firing was done on the proving-ground from a steady platform, and with no attempt at accuracy of aim, we can not believe that their rates of aimed fire at a moving object from so unsteady a platform as that of a vessel at sea would much exceed one-half of those given above.

In the two calibres of Canet guns, neither one of which has yet been mounted on board ship, fixed ammunition is used, but it requires two men to handle a cartridge. Under these circumstances a rate of unaimed fire of twelve shots per minute has been claimed for the 4.724-inch gun, and of six for the 5.91-inch. With the latter gun, which has recently attained a muzzle velocity of 2,749 f. s., pointing is effected either by hand wheels and gearing, as in other types, or by means of electric motors, the two arrangements being so connected that, by means of a lever, either can be used at will. This electric gear not only permits of increased rapidity in pointing, but also adds to convenience and accuracy, by allowing the gun to be entirely manipulated by the person who is to fire it.

The rate of aimed fire of these largest calibres is sufficient to make the disappearance from service of the corresponding calibres of high-power guns only a question of time. This increased rate of fire, at distances at which these guns will penetrate, makes the 6-inch equivalent to two 6-inch high-power guns, at the lowest estimate. This, of course, will not be true in the case of torpedo defense, where one gun, at least, will be required to take care of each attacking torpedo-boat.

To more clearly demonstrate this advantage, we will compare the English 6-inch B. L. rifle with the largest calibres of the Armstrong and Canet types of rapid fire guns.

	6-inch B. L. rifle.	Rapid fire gun.	
		6-inch Armstrong.	15 centimetres (5.91-inch) Canet.
Calibre … ins.	6	6	5.91
Total weight … tons.	5	5.5	6.2
Length of bore … cal.	32	40	45
Weight of charge … lbs.	42	38	33
Kind of powder …	Prismatic.	Smokeless.	Smokeless.
Weight of projectile … lbs.	100	100	88.9
Muzzle velocity obtained … f. s.	1,920	2,339	2,749
Chamber pressure … tons per sq. in.	16.5	16.5	18.4
Muzzle energy … f. t.	2,556	3,797	4,654
Energy per ton of gun …	511	690	751
Muzzle penetration in steel … ins.	9.7	12.8	15.1
Probable rate of aimed shots per minute …	3 in 2 minutes.	3	3

This Canet 15-centimetre gun has lately attained a muzzle velocity of 2,887 f. s. with a safe chamber pressure. This corresponds to a muzzle penetration in steel of 16.2 inches. Unfortunately full details of the trial during which this velocity was obtained, have not yet been received.

We can readily see that the value of a steady, well-directed fire from the guns of this new system in disturbing and in keeping down that of an enemy, as well as in disabling offensive weapons and personnel, can not be over estimated, and that the power of penetration of their projectiles is so great that, at the distance of a mile, nothing but an armored vessel can withstand them. So fully are these factors recognized that an extra thickness of armor protection is to be given to the armament and personnel of all lately designed foreign war vessels. The *Trafalgar*, the first vessel of the English navy in which the 4.724-inch rapid-fire gun was placed, has been fitted with an additional box battery of 3-inch steel plating, in which the gun is mounted, and still further protection has been afforded the crew of the gun by a 4¼-inch steel shield.

The essential features in which all rapid-fire guns, except those of the Armstrong type, differ from high-power guns are as follows:

The special mechanical arrangements in use for operating the breech mechanism, for firing the gun, and for extracting the empty cartridge case; the use of fixed ammunition, which renders an obturator unnecessary and reduces windage to a minimum; the use of special mechanism for checking recoil and returning the gun to firing position, by which there is no appreciable loss of time from running out and relaying; and, in all except the highest calibres, the use of a shoulder rest and pivot bearings, by means of which the gun can be kept constantly trained on a moving object. The Armstrong guns are not to use fixed ammunition.

As to the position which these guns will hereafter occupy on board ship: Although possessed of great power and accuracy, they will never displace the high-power gun of above 6-inch calibre. Up to the present time their use has proved that they fill a place intermediate between the turret or broadside high-power guns and the revolving cannon and machine guns. In small vessels carrying light armaments, the larger calibres of this system, from 4-inch up to 6 inch, will probably form the main batteries.

At ranges up to 4,000 yards, beyond which it is not considered that single-ship actions will commence, as, at greater distances, hitting a moving vessel would be an astonishing combination of good fortune and skill, the higher calibres of these rapid-fire guns will make a good record against the unarmored parts, which, even in most armored vessels now afloat, is much in excess of the armored portions; and, at closer ranges, against exposed chases of guns and the personnel. Continuous rapid firing will not be likely to be brought into play until at comparatively short range, as there is a limit to the time during which the maximum rapidity of fire can be maintained without danger of injury to the gun. A few minutes of such firing will cause the chase to become very hot, in consequence of which the maximum rapidity of fire should only be employed at very important or critical moments.

At the best, when able to penetrate, their projectiles would punch but small holes, and occasion nothing like the effect that would be produced by the larger projectiles, with powerful bursting charges, of large calibre high-power guns.

All the various types now in use in the principal naval services, calibre for calibre, will give within narrow limits about the same results. The best gun will be the one which will prove itself not only the simplest but the most enduring, and the least liable to get out of order. In other words, the one which will inflict the most damage in the least time, and with the the least strain upon the gun and its breech mechanism.

Such a gun will be worth but little, however, unless its crew is properly trained to its use, its value being due rather to its possibilities of accuracy from an unsteady platform than from its rapid rate of fire.

With this gun no shot should be thrown away, and such will only be the case when it is fired by a reliable marksman who has been kept in steady practice. The results obtained will depend more upon the gunner than upon the gun, and with no gun will practice count for more than with this, especially in night work by the illumination obtained from electric search-lights, where the conditions differ so greatly from those incident to shooting by day-light, and where only much steady practice will give an otherwise good marksman confidence in himself.

The successful use of guns of this system up to a calibre of 6-inch, will necessitate efforts to obtain greater rapidity of fire from high-power guns and much quicker means for supplying ammunition.

The next step in the development of rapid-fire guns will be a change in the tube, a decrease in size of the powder chamber, and a strengthening of the walls of the chase, necessitated by the use of smokeless powders, which, with smaller charges than of ordinary powders, give the same chamber pressures, but higher pressures all along the bore.

Details of all types of this system referred to in this article are to be found in the publications of this office from No. VI to No. IX, inclusive.

X.

THE YEAR'S DEVELOPMENTS OF HOME RESOURCES FOR THE PRODUCTION OF WAR MATERIAL.

By Ensign J. B. BERNADOU, U. S. Navy.

One of the benefits of a settled naval policy whose character of permanency is evinced by development continued through a series of years, is a constantly increasing willingness of capital to lend itself to the creation of new and improved plant, and to aid in developing the resources of such sections of the country as may be selected as sites of future naval establishments. The question of a proposed gun foundry or navy-yard is no longer considered with indifference by business men, but is discussed by them as a significant issue. It is realized that whereas in former times ships were built for the greater part at national yards, of timber taken from Government reservations, at the present day these vessels are constructed of material wholly supplied by private manufacturers, furnished by widely-scattered sections of the country, and wrought into hulls, in many cases, at private establishments.

The opinion that the development of the Navy is beneficial to the industries of the country at large is not confined to naval circles, but is shared by observers in other branches of the Government service. In his report to the Secretary of the Treasury for the year 1889, the Commissioner of Navigation says:

> Government work has formed a large part of the world's ship-building for the past year. In the United States building during the past season has been brisk and, including work done on Government vessels, and on vessels for the coasting trade, the yards have been reasonably busy. Many contracts for new vessels have been awaiting the completion of vessels already on the stocks. The iron and steel business will be benefited by this activity in our yards, and it is hoped that a permanent revival in our ship-building industry has come. If this hope should be fulfilled, relief will be given to hundreds of other industries.

In considering the recent increase of our Navy, it is well to realize what this increase has done towards supporting the industry of ship-building during a period of inactivity and depression. The total steam tonnage built upon our sea-coasts during the fiscal years 1888 and 1889, is given in the report of the Bureau of Navigation, Treasury Department, as 96,000 tons, of which 71,000 were built on the Atlantic, and 25,000 on the Pacific. The approximate tonnage built by private firms for the Government during the same period, and which is not included in the above amount, was 28,000 tons, of which 20,000 were built on the Atlantic, and 8,000 on the Pacific; so that the Government has supported the ship-building industry during this period to the extent of ordering about 22 per cent. of the Atlantic steam tonnage and 24 per cent of the Pacific.* The tonnage amounts involved in the above comparisons are small indeed, but they are significant as showing the value of the Navy in the support and the development of the industries of the country at large.

The recent rapid growth of lake commerce has given a very great impulse to ship-building in the Lake States. In 1888 and 1889, as shown by official returns, the tonnage of steam vessels built at our ports in these regions amounted to 181,000. The total steam tonnage built upon the Atlantic and the Pacific coasts during the same period was about *one half the amount.*

It has been asked whether the development of ship-building upon the Great Lakes could have any effect upon our naval establishment. To this question the following extract from the Engineering News, of April 19, 1890, will serve to furnish a partial answer:

> Ship-yards on the Lakes are to turn out vessels of 124,000 tonnage in the aggregate for 1890. At Bay City, Mich., in the ship-yard of Mr. F. W. Wheeler, are now building two steel steam-ships for the Atlantic. They will be 275 feet long, 41 feet beam, 26½ feet molded depth, and will each carry 3,500 tons with 20 feet draught.
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> As the Canadian canal locks are too small to take vessels of this size, they will be towed to Buffalo, and there cut in two, by removing the rivets, at a point where a permanent bulkhead crosses the ship. A temporary bulkhead in the other half, put in at the yard, will provide two distinct boats for navigation through the Welland and St. Lawrence canals and the lake and river to Montreal. At the latter place the two halves will be again joined in a dry-dock, and the ship will then steam to Newport News, to carry coal to New York or Boston.

The development of the railroad may be said to have made the modern steam-ship a possibility; wherever a plant for the fabrication of steel rails exists a source of supply of ship's material may be counted upon; wherever a railroad meets a sea-coast a hull may be constructed, and at no other points, for nowhere else does there exist a certainty of delivery of supplies furnished by every section of the interior.

As a marked example of aid afforded to ship-building enterprises by improved communications may be cited the recent rapid growth of the plant of the Union Iron Works of San Francisco, Cal. The history of this establishment is remarkable, especially in its relations with the necessitated transportations of material, machinery and supplies over long distances. The needs in this direction are constantly decreasing, however, as the general elaborations of the manufacturing and mining facilities of the Pacific coast arefast leading to the creation of centres of supply in the far west, and are thus rendering western ship-building a self-supporting industry. The Union Iron Works are now interested in the development of a steel producing plant at Seattle, and the important part that they have taken since 1885 in the rebuilding of the Navy is abundantly attested to by work already accomplished, as well as by contracts now in hand.

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* These figures are to be taken as approximations. If the tonnage of *ships building* be added to that of *ships documented* within the year, which is what the figures given for merchant vessels represent, the percentage in favor of the Government would be lowered. On the other hand, if the gross tonnage of the merchantmen be reduced to displacement, the Government figures would be raised.

Some of the transportations that have been necessitated in the creation of a naval structural plant have well tested the capacities of our railroads, and are significant, as they serve to indicate, in certain directions at least, the present state of the transportation facilities of the United States. In this connection, the recent transfer of the armor plate bending rolls from their place of fabrication at Hamilton, Ohio, to the navy-yard at Mare Island, Cal., is worthy of special notice. The following brief account of the operation is appended to the official report of acceptance, which was published in the Army and Navy Register, of April 19, 1890.

> The armor plate bending machine made for the navy yard at Mare Island, Cal., was shipped from the Niles Tool Works over the Cincinnati, Hamilton and Dayton, and Southern Pacific railroads. The machine was loaded upon eleven specially built and extra heavy flat cars. The two largest castings weigh respectively 66,400 pounds and 66,200 pounds, and the gross weight of the train was 675,350 pounds. This train will be run through the entire distance, 3,400 miles, without change, the distance being greater than the entire system of the Canadian Pacific. The railroad company will not attempt to make fast time, owing to the weight of the castings. The whole train will be run on an especial boat at San Francisco and taken up the Sacramento River. The freight, which was prepaid, amounted to a little more than $10,000. This is the longest distance any solid freight train ever traveled, and it is the largest shipment of any one single machine ever made in the United States.

Since the time of the publication of this notice the transfer has been successfully accomplished, and the machinery has arrived at its destination without mishap.

Among the very favorable results that are due to the impetus recently given the work of naval construction are the noteworthy expansions and developments effected in the plants of private ship-building firms. The number of bidders upon the contracts for Government vessels is increasing, and the list of those who compete for the building of the smaller vessels especially, would seem to show that the attention of ship-builders in all sections of the country is directed to what is now regarded by them as a line of assured national development.

The Bath Iron Works, of Bath, Me., one of the leading New England firms in the construction of sailing vessels, have turned their attention to the new line of Government work, and have recently been awarded contracts for the construction of gun-boats Nos. 5 and 6. In selecting a suitable water front, and in preparing their plant for the undertaking, the advice of naval officers was followed; and this fact will serve to illustrate the important and beneficial aid to technical development that is afforded by naval officers in time of peace. Messrs. Moore & Sons, of Elizabethport, N. J., have also given intimation that they will hereafter regularly enter the lists of competition, and have already appeared as bidders. The extensive and efficient plant of the Pond Machine Tool Works, with which these gentlemen are associated, will aid them in their undertakings. The Columbian Iron Works, of Baltimore, Md., have already built the *Petrel*, of 870 tons displacement, and are now engaged upon two larger vessels of 2,000 tons displacement each, both of which are well under way and in advance of all time allowances. The establishment of Harrison Loring, of East Boston, which did good work during the war, has again come to the front, and holds the contract for one of the 2,000 ton cruisers. The Pennsylvania Steel Company, whose plant is now in process of erection at Steelton, Md., are associated with Messrs. Harlan and Hollingsworth, of Wilmington, Del., who formerly took an important share of naval orders, and there is good reason for supposing that the new establishment will prove one of the largest and best equipped in the United States, and will soon enter as a factor of the first order in effecting future naval increases. The Atlantic Iron Works, of Boston, Mass., noted for the construction of steel steam and fire tugs, and wrecking craft, and the Willamette Iron Works, of Portland, Oregon, have also intimated their intention of appearing as Government bidders; the latter are pioneers in the work of developing the ship-building industries in the new section of the northwestern coast, where facilities for naval construction as properly belong as they do in New England on the northeast. And very recently a most valuable addition to the list of southern establishments has been made in the Chesapeake Dry Dock and Construction Company, of Newport News, Va., who have applied for plans and specifications, and who contemplate submitting bids in the near future for the construction of large vessels.

Among the important advances recently effected in the manufacture of steel for naval uses may be noted the introduction and present rapidly increasing employment of basic steel in hull and boiler construction. The specifications for the hull and the machinery of the *Maine*, issued on May 4, 1888, and July 4, 1888, respectively, are the first to contain definite mention of the kind of metal to be employed for the various classes of structural material. The words "ordinary open-hearth steel" are therein used. Beginning with those for the monitor *Terror* and class, in January, 1889, all specifications subsequently issued contain the words "steel by the open-hearth process," thus allowing the employment of basic open-hearth steel. At the present time the Homestead Steel Works are those most extensively engaged in the manufacture of basic open-hearth steel in this country. The first basic steel produced in the United States was made at the works of the Otis Steel Company.

About one hundred and sixty heats were run and the process was then abandoned. Subsequently it was started at the Homestead Works, where it is still continued. In their present plant, consisting of seven furnaces, only one is making acid steel, the other six making basic. In the new plant which is nearing completion there will be eight furnaces, almost all, if not all of them, being for basic steel. Four of these furnaces are expected to be working in August.

At the present time the Southern Iron Company, of Chattanooga, Tenn., is putting up two furnaces, and the Pennsylvania Steel Company, at Steelton, is putting up a number. Also, as a further extension of the process, the Illinois Steel Company, of South Chicago, contemplates the erection of a number at their South Chicago works.

The basic Bessemer process was tried at Steelton and at Pottstown, but was abandoned on account of the cost of labor, as well as certain initial difficulties, although its manufacture proved a technical success in both instances. The development of the basic open-hearth process at the Homestead Works has proven the existence of many disadvantages, but on the whole these are decidedly outweighed by the advantages,and there is reason for general satisfaction at the very successful results obtained. Among the disadvantages may be mentioned that the process was found harder to control; that more care had to be taken with the composition of the charges; that results obtained were more irregular. The basic furnaces burned out more rapidly, probably in one-fourth the time that the acid furnaces would last, and no refractory substance could be found that would satisfactorily resist the severity of the exposures. Basic charges were often found to be what is technically termed "wild," there being always considerable uncertainty as to the nature of the metal produced. At works where orders are constantly on hand for steel of widely different qualities, any heat can be utilized, even if it does not turn out as originally intended. If it is soft it can be put into ship plates, or low boiler plates; if hard, into high boiler or protective deck plates, or plates for ordnance uses. Nothing is lost. With a less varied demand this irregularity might prove disastrous. Then again, care must be taken in the selection of the charges. It was at first supposed by the manufacturer that any kind of pig metal could be put into a basic furnace and good steel turned out, but practice has disproved the theory. Even more care must be taken than with acid charges, except that iron of higher phosphorus can be used.

The very great advantage of the basic process and the one worthy of general notice is the possibility that it affords for a more general use of *American ores* for low phosphorus steel. In the acid process, even with foreign ores, it is difficult to get steel of below .035 phosphorus. In Pennsylvania there is no ore from which steel containing below .06 per cent. of phosphorus could be made by the acid process except in the Cornwall district, and there it contains so much copper that it can not be used. Only a few years ago it was difficult to get even Bessemer pig in sufficient quantity. The manufacturer was obliged to take what he could get without guarantee as to phosphorus, but now, since the opening of the Gogebic and the Vermillion mines in Michigan, the supply is plentiful, and manufacturers are able to get a selection and a guarantee too. For the acid process the supply of ore for low phosphorus steel is still quite limited, while for the basic process it is practically unlimited.

The following statement of the qualities of basic steel is taken from a paper by Lieut. Commander J. G. Eaton, U. S. Navy, published in the proceedings of the United States Naval Institute, 1889, Vol. XV, No. 2.

> Basic steel can be made purer than by any other known process. When very pure the tensile strength is low, but the reduction of area under stress is highest. The strength can be raised by carbon alone to over 60,000 pounds per square inch, which is sufficient for ship-builders' needs. Basic steel has more the qualities of high-class wrought iron, minus the blisters, slag, and laminations to which the iron is subject.
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> Basic steels weld very readily with ordinary care, possess remarkable qualities as to malleability, and forge more readily than other steels. These qualities fit them pre-eminently for fire-box and furnace-plates. Basic plates are free from snakes, one of the worst defects in thick plates or heavy sections. Basic steel is eminently fitted for angles, beams, and rivets. Its strength is not affected to the same extent as other steels by annealing, and instances are not wanting where it has actually gained tensility in the annealing furnace. No advantage is gained as to quality by subjecting basic open-hearth steel to excessive mechanical compression. The same uniformity of texture is gained by much less work. Basic ingots are much quieter in the molds than acid ingots. Basic plates show less variation between longitudinal and transverse specimens than acid steels. In a record of thirteen heats from furnace No. 1, basic open hearth, at the Homestead Steel Works, comprising 100 plates and tests, the average variation between longitudinal and transverse specimens was: in tensile strength, 1,120 pounds; in elastic limit, 870 pounds; in elongation, 8 inches, 2.2 per cent.,—whilst thirteen acid heats from furnace No. 4, of the same average strength and elongation, showed for the same number of tests average variations as follows: in tensile strength, 2,740 pounds; in elastic limit, 1,320 pounds; in elongation, 8 inches, 3.8 per cent. The analytical tests showed more uniform distribution and less segregation than in acid ingots.

The facility with which high tensile armor-plates are now produced marks another great improvement in the production of steel for naval uses. The specifications of May 24, 1889, for cruisers Nos. 7, 8, 9, 10, and 11, and gun-boats 5 and 6, call for a tensile strength of 80,000 pounds with an elongation of at least 18 per cent. in 2 inches. After a period of experiment with charges, marked by a tendency to run to higher tensiles and lesser elongations, manufacturers have been able to produce protective deck plates running with remarkable evenness in the neighborhood of 80,000 pounds, with an elongation of from 18 to 25 per cent., so that where not long ago it was the exception when a plate passed, it is now the exception when one is lost.

Another improvement of note is that there is no longer any difficulty experienced in furnishing castings with a low percentage of phosphorus. But a short time ago, when castings were first successfully made in large numbers, the limited control of technical processes prevented any surety in reducing the percentage of phosphorus below .07 or .08. At present castings are produced with facility with the phosphorus down to .05 or .06 per cent.

In the Proceedings of the United States Naval Institute, Vol. XV, No. 4, 1889, Mr. W. H. Jaques gives the following account of the ordnance and armor plant of the Bethlehem Iron Works:

This department, now in operation, when completed, will comprise gas producers, open-hearth furnaces, fluid compression apparatus, soaking pits, hydraulic forging presses, plate rolling mills, crucible furnaces, hydraulic and pneumatic cranes, a 125-ton single acting steam hammer, bending press, oil-treating and annealing shops, and machine shops.

The open-hearth furnaces will have a capacity for casting ingots of 100 tons.

The hydraulic forging presses will produce the largest forgings for ships of any tonnage thus far designed, and for guns of the largest calibre. A specialty will be made of hollow forgings of large dimensions.

The plate rolling mill will be capable of supplying all probable demands for rolled plates of every description.

The pneumatic and hydraulic cranes have a capacity of from 25 to 150 tons.

The building containing the open-hearth furnaces, forging presses, fluid compression apparatus, and plate mill, is 1,155 feet long by 111 feet wide with transept and annexes for engines, gas producers, etc.

The oil-treating and annealing shops are conveniently arranged for economical treatment of heavy gun and other forgings and of armor-plates.

The machine-shop contains lathes, planers, boring mills, slotters, drilling machines, shapers, etc. Among these are: a planer, in which 13 feet by 13 feet by 50 feet 10 inches can be planed; 10-foot face plate lathe; boring mills of the most recent design, and some of the most powerful lathes in existence. The building is 641 feet in length by 116 feet wide.

The traveling cranes are of the pneumatic type, 60 feet span, and from 25 to 100 tons capacity.

The shops are well lighted by electricity, and the entire plant supplied with efficient rail communication and adequate rolling stock.

The casting and forging presses were manufactured by Sir Joseph Whitworth & Co., of Manchester, England, and designed by Mr. Gledhill, managing director of that firm. The heavy tools were constructed from designs by Mr. Gledhill and Mr. Fritz, and all erected under the latter's direction.

In the designing and erection of the hammer plant for making armor-plates, the plans of Schneider & Co., of Creusot, France, were consulted and followed as far as they met the principles of construction already adopted.

The department for the production of heavy forgings for guns, armor, shafting, and other purposes, is rapidly approaching completion, and within a year will equal, if not surpass, any other establishment of this kind in the world in its capacity to supply war material, and the perfectness of its means of rapidly producing the heavy forgings required for modern high-power ordnance and the most powerful armored ships yet designed. With a casting capacity for ingots of 100 tons, fluid compression plant, a steam-hammer of 125 tons (falling weight), the most powerful hydraulic forging presses ever constructed, and tools of the most improved and advanced types for shaping and finishing, this company has already manufactured and delivered all of the heavy shafting of the cruisers *Philadelphia*, *San Francisco*, and *Newark*, together with forgings for 4-inch, 6-inch, 8-inch, and 10-inch breech-loading rifles, and is now engaged upon the shafting of the armored coast-defense vessel *Maine*, and 8-inch, 10-inch, and 12-inch breech-loading rifles for both the Army and Navy, and the armor of the barbette ship *Puritan*, the double turreted monitors *Amphitrite*, *Monadnock*, and *Terror*, the battle-ship *Texas*, and the armored cruiser *Maine*.

In addition to the war material (including hollow and other forgings for shafting, guns, armor, shields, and conning towers), special and miscellaneou forgings, the works have an output of some 250,000 tons of rails, blooms, and billets, and miscellaneous work, under a personnel of about 3,000.

The chemical and physical laboratories are very complete, and contain Riehle and Emery testing-machines of 100,000 and 300,000 pounds capacity.

The Company's property at South Bethlehem covers an extent of about 1¼ miles in length by one-quarter of a mile in width, of which about 18 acres are under cover.

In relation to the Bethlehem plant, the report of the Chief of Ordnance, Navy Department, for 1889, contains the following:

> The plant of the Bethlehem Iron Works for the manufacture of gun forgings has been virtually completed since the last report, the two hydraulic forging presses and the casting press being erected in place, and most of the steel furnaces finished. The plant for rough turning and boring forgings is also about completed.
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> The two hydraulic forging presses and the fluid compression casting press all seem to work as designed, and it would appear now that the company should deliver forgings with considerable rapidity, as it is equipped with a plant of the most modern kind.
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> As the plant at these works is of superior character, it has been found practicable to simplify the construction of our guns by having most of the hoop-forgings made longer than has heretofore been practicable, thus reducing the amount of work in assembling, and adding also to the resistance of the guns to longitudinal flexure. The advantage is also gained of more uniform maintenance of the shrinkage throughout the length of the gun, owing to the less number of divisions between the hoops.
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> The construction of the 120-ton hammer, to be used in the forging of armor-plates, has made good progress. The building to contain it is very well advanced, and a number of the large castings connected with the hammer itself are completed. The preparation of the site for the hammer, particularly as regards the foundation of the anvil, has involved great labor and difficulty, and the work has been prosecuted with energy. The hammer will probably be completed within a year.

As an indication of the progress realized by the Bethlehem works, it may be stated that they are now gaining their allowance for 10 and 8 inch gun-forgings by furnishing them eleven months ahead of contract time, and are behind in nothing.

Perhaps the most significant event in the progress of the year is the very recent obtaining of an assurance of a supply, within the next twelve months, of armor-piercing projectiles of domestic make. Up to the present time there has been no assurance whatever of the satisfactory production of these projectiles by our manufacturers, for the special technical processes employed in their fabrication have remained unknown to them.

In General Information Series, No. VIII, it was stated that the Bureau of Ordnance had been trying to produce chrome steel of domestic make suitable for armor-piercing projectiles. Samples had been submitted which had not altogether proved satisfactory, and experiments were in progress. With a view to developing their manufacture the bureau had advertised for a large number of finished projectiles for the 6-inch, 8-inch, and 10-inch guns, and it was hoped that their production up to the requirements of the French standard would soon be undertaken.

In the report of the chief of the Bureau of Ordnance for the next year, 1889, occurs the following statement:

> Armor-piercing shell made by the most reputable firms in Europe have reached such a state of perfection that they pass readily through targets of one and a half cali-

bres in thickness without material deformation, and it is necessary that the armor-piercing shell made in this country should show equally good qualities. The Bureau has been endeavoring now for several years to procure successful projectiles of this kind, but as the results thus far obtained have been unsatisfactory it was decided to advertise for a quantity of these projectiles aggregating in value about $50,000, it being hoped that some of the private manufacturers might be thereby induced to obtain the formulas and methods of treatment from abroad, and introduce them into the United States. Subsequently, owing to the urgency and importance of the matter, the Department increased the money value of the projectiles advertised for from $50,000 to $200,000. The time for opening the bids under this advertisement has not yet arrived, but it is hoped that some responsible firm, with the necessary mechanical and chemical facilities, may be induced to undertake seriously the manufacture of these projectiles.

As a result of the pecuniary inducements offered, and in view of the prospects of future demands, the Carpenter Steel Company, of Pittsburgh, Pa., has acquired the methods of the Firminy, one of the most successful of the foreign processes, and has recently entered into a contract with the Navy Department to furnish about fifteen hundred projectiles for the 6-inch, 8-inch, 10-inch, and 12-inch calibres, the delivery to begin in four months and to be completed within a year. That this is a matter of congratulation is self-evident.

In General Information Series No. VIII, for the year 1889, mention was made of the successful results of the efforts of the Navy Department to establish within the United States a plant for the manufacture of revolving cannon and rapid-fire guns. To this end the following order was guaranteed to the Hotchkiss Company of Paris, France, on condition that the plant for its execution be erected in the United States:

6-pounders	30
3-pounders	22
1-pounders	10
37^{mm} revolving-cannon	32

The offer was accepted and the work was begun in 1887.

After considerable initial difficulty the steel was satisfactorily produced by the Midvale Company. The manufacture of the guns was commenced by the Pratt and Whitney Company, of Hartford, Conn., and that of the ammunition by the Winchester Arms Company, of New Haven, Conn.

Recent reports show that of the above order the following portion was delivered by the close of the year 1889:

6-pounders	19
3-pounders	12
1-pounders	10
37^{mm} revolving-cannon	32

together with forty-eight thousand rounds of ammunition, so that the successful domestic establishment of this new branch of ordnance manufacture is now proven. In response to the increasing demands for rapid-fire guns the Driggs-Schroeder design has been successfully developed, while negotiations with a view to the establishment of the manufacture of the Maxim rapid-fire guns in the United States are in progress.

The manufacture of all classes of electrical apparatus for the installations of the new ships has made satisfactory progress during the year. The applications of electricity on shipboard and ashore at naval stations are constantly increasing in variety as well as growing in importance. Projectors of standard type are manufactured by the Thomson–Houston Company, and are now supplied to a number of vessels. This firm has built the dynamo-engines of the *Petrel* and has contracted for those of the *Newark* and *Vesuvius*. The dynamo-engines of the *Concord* and *Bennington* are to be supplied by the Ball Company, of Erie, Pa. During the last year a complete and well equipped lighting plant has been installed at the Washington ordnance yard by the Brush Electric Company, of Cleveland, Ohio, while rapid progress is now being made in the establishment of plants at the New York, Mare Island, and Norfolk navy-yards.

In 1883 an electric lighting plant was experimentally installed upon the U. S. S. *Trenton*. To-day, in 1890, there are eighteen installations for Government vessels established or contracted for; and the electric plant is recognized as a regular and most important component of the equipment outfit of every battle ship and cruiser.

The process of electric welding, which has recently undergone a rapid development, possesses a broad application in the useful arts and is directly related to some of the more important branches of naval construction work. Prof. A. B. W. Kennedy, F. R. S., in a report made to the Corporation of the City of London upon the Thomson process, says:

> The works of the Thomson Electric Welding Company at Lynn were started about a year since, but have only been finished about five months. They now employ about two hundred and fifty men. The shops are stocked with excellent tools and are full of work, consisting mainly of Thomson Welders and the dynamos for working them. At the date of writing (February, 1890) 36 welders of all types, with the necessary dynamos, had been actually delivered at works in the United States, while 43 others were at hand in the shops on order for different commercial purposes.

The following list of the machines and of their applications, taken from the same report, will serve to show the general utility of electric welding in all branches of metal working:

Uses to which machines are put.	Employed.
Iron and steel wire	9
Hard steel (gun) wire	2
Copper and brass wire	3
Copper rods, to 1 inch diameter	4
Pipe, from 2 to 6 inches diameter	4
Axles, tires, etc	35
Hardware	7
Brazing and welding	3
Upsetting collars on axles	2
Steel wire cable welding	2
Lead strips	1
Rail splicing	1
Upsetting bridge eye-bars	1

Three noteworthy applications of electric welding to naval work relating to important operations in ordnance, equipment, engineering and construction departments, are already contemplated.

(1) A board of naval officers, of which Commander G. A. Converse, U. S. Navy, was president, have investigated the Thomson process and testified to its great utility in the naval service, both ashore and afloat "for welding breaks in rods, angles, and shapes of intricate form; for welding copper, brass, cast-iron, and other metals; for heating metals, and for forging and for welding wire cables." Two classes of welders, designed for use ashore and on shipboard respectively, have been recommended, the latter with a view to lightness and adaptability for general work.

(2) The Thomson Company now control the patents of Lieut. W. M. Wood, U. S. Navy, for a new system of fabrication of projectiles, a solid rolled steel tube to be connected by welding with a butt and a chilled head. In view of the successful practical development of other welding processes, the existence of a new source of supply of small projectiles would seem to be guaranteed.

(3) The naval appropriation for the current year contains the following provision:

> For installing an electric welding machine at the Boston navy-yard, $12,000. *Provided,* That the parties supplying the said machine shall guarantee that it will operate satisfactorily in the welding of steel links for chain cables of the various sizes up to 2¼ inches in diameter, and no payments shall be made until tests shall have been made to the satisfaction of the Secretary of the Navy.

This latter use marks an application of electricity to structural operations of the first order. It is difficult to realize that the force that ten years ago could only be utilized in ringing a call-bell or exploding a primer is now employed for the fabrication of the cables upon whose strength the safety of the ship depends.

XI.

LIQUID FUEL FOR TORPEDO-BOATS.

By Passed Assistant Engineer C. W. Rae, U. S. N.

In order to arrive at a conclusion as to the advisability of using liquid fuel in torpedo-boats, it will be well to examine the subject systematically, and in order to do so the following divisions of the theme have been made, viz:

1. Methods of burning the fuel.
2. Cost as compared with coal.
3. Safety in stowage and use.
4. Advantages and disadvantages.
5. Conclusion.

1. METHODS OF BURNING THE FUEL.

Herr Busley, of Kiel, the distinguished marine engineer, has, in a series of papers which appeared in the Wochenschrift des Vereines Deutscher, classified the different types of burners, thereby greatly simplifying the study of that part of the subject.

Herr Busley's divisions are (1) hearth fires, (2) gas fires, and (3) spray fires.

(1) HEARTH FIRES.

Under this class are included all those methods in which the fuel is burned in its liquid form. It is subdivided into (1) pan fires, (2) step fires, (3) drip fires, and (4) oozing fires.

(1) *Pan fires.*—This is the simplest and most primitive form of burning liquid fuel. In most cases the fuel is led to the furnace by gravity, and flows over flat plates or in shallow bowls, equal distribution being effected by grooves in the plates radiating from the point of admission. The oil is ignited by contact with live coals. The great objection to pan fires is the impossibility of supplying enough air for complete combustion, which occasions large volumes of smoke.

(2) *Step fires.*—This system consists of a series of iron troughs arranged in the form of steps. The oil is fed to the upper one and overflows into the one next below, and so on. A much more perfect combustion is obtained than with the pan fires, as the supply of air is greater. Owing to the rolling of the ship this method is not applicable to marine purposes.

(3) *Drip fires.*—In this system there are usually numerous small pipes, each fitted with a regulating valve, leading from a common supply-pipe and discharging into other small pipes provided with funnel-shaped mouths, after the manner of certain sight-feed oil-cups. The oil is spread over the floor of the furnace, which is inclined to the rear, and burned in conjunction with air admitted through valves in front of the furnace. In one of the furnaces falling under this subdivision the oil is distributed by running down the grooves in the grate-bars, there being as many bars as there are pipes and the air being forced up from the ash-pit below. This separation of the oil is an advantage, as the air has readier access to it.

(4) *Oozing fires.*—In this system the floor of the ordinary furnace (the grate-bars being removed) is covered over with some porous material, ordinary burned slaked lime, sand, coal dust and small stones, asbestos, etc., and the oil is introduced underneath. The porous substance becomes saturated with oil, which is fed from the tank by gravity, and burns from the surface. In Richardson's furnace combustion is aided by a jet of superheated steam.

(2) GAS FIRES.

Under this head are classed all those devices in which the fuel is conducted to the furnace in a gaseous state. Comparatively there are not many of this class. Among them may be mentioned Shaw and Linton's, the Foote furnace as applied to the U. S. S. *Palos* in 1867, and Dorsett and Blythe's.

The chief fault with gas-furnaces is the stopping up of the supply-pipes, the residuals not vaporizing.

(3) SPRAY FIRES.

In spray fires the oil is injected in the form of small jets or sprays by means of steam and air blasts. More air is introduced near the flame, and nearly perfect combustion results.

Herr Busley divides the sprinklers, the name applied to the spray burners, into three classes: (1) slit sprinklers; (2) pipe sprinklers; (3) nozzle sprinklers.

(1) *Slit sprinklers.*—The general design of the earlier of these sprinklers consisted of a thin narrow orifice divided longitudinally by a knife-edge partition, from one side of which came the oil, and from the other side the steam. Many changes in the form of the slit have been made by

inventors, in each case with an accompanying list of advantages. Some of the principal slit sprinklers are the Lenz, the Körting, the Artemev, the Karapetov, the Brandt, and the Jensen.

(2) *Pipe sprinklers* consist of an arrangement of concentric pipes, through one of which passes the oil, and through the other the steam, fitted either with regulating valves or with the inner pipe made movable, axially, so that the size of the orifice may be altered. Air is sucked in by means of the steam blast, and is also supplied through openings made for the purpose.

The principal advantage of the pipe sprinkler is that the flame is spherical in shape and thus more completely fills the cylindrical furnaces of marine boilers, giving a more even distribution of the heat.

(3) *Nozzle sprinklers.*—The largest and most important division, and the last one in Herr Busley's classification, is the nozzle sprinkler. A more detailed notice of the devices falling under this head is given than in the previous cases, as here are to be found the most successful burners, and among them are classed the inventions of Mr. Urquhart, locomotive superintendent of the Grasi-Tsaritzin Railway of Russia, than whom no one has given the subject more attention.

In the Aydon, Wise and Field burner, the oil enters the sprinkler from a vertical pipe through an opening of about one-eighth inch in diameter, flowing from a tank at a higher level. It is forced into a discharge pipe by a stream of superheated steam escaping from a horizontal pipe, which sucks in air from a funnel on top of the sprinkler. The oil, steam, and air are discharged from the mouth of the sprinkler against a fire-brick wall which breaks up the stream and exposes it to the heat, thereby securing more perfect combustion. The supplies of oil, air, and steam are regulated separately.

Aydon and Selwyn's sprinkler is a modification of the above, in that the oil and steam pipes meet at an acute angle instead of at a right angle. This device, which was very successful, was used in H. M. S. *Oberon.*

Körting introduced two devices, the later one, in which the steam and oil pipes met at an acute angle as in Aydon and Selwyn's, was provided with a stopper in line with the oil nozzle, which could be removed and the oil pipe cleared by means of a needle attached to the burner by a chain.

In Dickey's sprinkler the steam and air nozzles are concentric, the oil nozzle being immediately in front of the two and at a right angle to them. The spray is thrown against a wall in the furnace composed of iron shutters, which can be turned on their axes, thereby regulating the quantity of air necessary for complete combustion. It was tried on a locomotive on the Long Island Railroad, and is said to have been very successful.

The last device of Mr. Urquhart, and the one whose success was such that it was fitted to 140 locomotives on the Grasi-Tsaritzin Railway, is as follows, viz:

In this the oil passes from tanks in the tender by means of a tube and a pipe into the sprinkler. The non-superheated steam leaves the dome of the boiler and enters the sprinker; it passes through orifices into the interior of a bronze spindle and escapes through the front of the nozzle. A spiral wheel which moves on a spring in a groove regulates the outlets for the oil. To obtain the requisite air, the sprinkler is fixed so as to protrude into a pipe-rest, and a space of about one inch is allowed between the flange of the sprinkler and the plate of the boiler. The oil and steam are separated inside the sprinkler by means of a box filled with asbestos packing, which latter has to be renewed about once a month. The admission of steam is regulated by a special valve in the pipe. * * * Should this sprinkler get stopped up for any reason the spindle has only to be screwed back, and the oil will force the carbonized particles into the fire box. Urquhart has also protected the walls of the pipe against the flames, and prevented all the deteriorating action on the boiler which their direct action entails, by lining the inside of the fire-box with brick. * * * The sprinkler is placed low down, and blows into a furnace chamber built into the fire-box and covered with a vaulted roof, which slants off in the direction of the tube plate. The brick-work does not lean against the wall of the fire-box, but is about 2 inches from it, so that these walls need not be lost to the heating surface. The flame beats from the furnace chamber against what used to be the fire-door, now bricked up (except a small peep-hole), and reaches the tubes through an opening in the roof of the chamber at this point. Two channels are built into the walls of the furnace chamber, and lead a portion of the heated gases to the lower surface of the tube-plate, as well as into the spaces between the brick-work and the outer walls of the fire-box, so as to give these an efficient heating surface. The requisite air is forced into the furnace by the sprinkler, and more air is admitted by the ash-pan dampers which are regulated by chains and chain-wheels. The air entering at the front ash-pan damper passes through a channel, and is warmed before being admitted to the gases. Complete combustion of the oil is insured by fitting the fire-box with tiles, which, being non-conductors of heat, keep the walls of the fire-box at an equal temperature, and even relight the oil-stream, should a short interruption of work occur. This also greatly simplifies management.

Spakovski's nozzle sprinkler, designed for burning oil residuals, has been used on steamers on the Caspian Sea.

Sadler's nozzle sprinkler, one of very simple construction, has been used for burning tar and heavy tar oils.

The nozzle sprinkler of d'Allest was tried in 1885, on the French steamer *Aude* * * *. Both the furnaces of the boiler were lined with fire-proof brick, which rested on the old coal-grate. Two sprinklers blew oil into each of the furnaces. The results were good so far as combustion was concerned, but the sprinkler consumed an abnormally large quantity of steam, as much as from 8 to 10 per cent. of the entire steam consumption. D'Allest then tried to vaporize the oil by means of compressed air instead of steam, to avoid the enormous loss of the latter, but the first experiments of this kind were not successful, because the blowers would not give sufficient pressure. In 1866 further experiments were made. In these the air was pressed by an air-pump into a cylindrical tank, and was conducted thence to the sprinklers, where it must have retained a considerable pressure. The oil flowed from a tank into the sprinklers in the boiler. The results of these experiments showed that the combustion of oil is much more perfect when it is vaporized by compressed air than when vaporized by steam, as, indeed, was proved by the increased whiteness of the flame. The best results were obtained with hot air; in vaporizing with cold air the walls of the furnace must be lined with fire-proof brick, otherwise the flame is nearly extinguished. The weight of air necessary to work the sprinkler amounted to about 5 per cent. of the steam generated.

Experiments were also made with the nozzle sprinkler of d'Allest to see whether oil fuel could be used in cases where an artificial draft was raised, and when it is especially necessary, as with the boilers of torpedo boats, to generate as great a weight of steam as possible per square metre of heating surface per hour. For this purpose * * * a clay receiver was placed in the furnace and two sprinklers were fitted in front of it. The vaporization could be effected either by steam or compressed air. The artificial draft was produced by a blower in a heater in the throat of the chimney, and was then conducted into a box which encased the two sprinklers. The results obtained in these experiments were very satisfactory, it is said.

D'Allest subsequently conducted a series of experiments on the torpedo boat *La Chevrette*, under the direction of the French ministry of marine. He at first tried to use compressed air to vaporize the oil as well as to supply draft, but this proved unsuccessful and he had to return to the use of steam. In a torpedo-boat boiler it is necessary to obtain a high evaporation in a small boiler. D'Allest claims that he secured this, and further, that he had complete combustion of the oil both with natural and forced draft. He stated that the result of his experiments was that with oil as fuel, a boiler one-fifth smaller could be used than with coal, a great advantage with a vessel of this class. An incidental advantage also was that when burning oil with forced draft the flues were never stopped up, as they frequently were with coal.

There seems to be no doubt of the superiority of liquid fuel in many cases of this kind, where the room allowed both for boilers and for storage of fuel is limited.

The following is a brief description of a few burners not mentioned by Herr Busley.

The "Cyclone" burner.—In this burner the atomizing is effected by passing the oil under pressure through a tube containing a revolving screw. The oil issues in the form of a cone made up of extremely small drops, and meets a current of air also forced in by a screw.

The oil must be supplied to the burner under a pressure of not less than 35 pounds. This pressure can be obtained in several ways; usually a small steam pump will be the most convenient.

The makers give the following hints as to the use of this burner:

For the purpose of starting the burner before steam is at disposal, the steam pump can be fitted with a hand-power attachment, but a separate small steam-boiler, or an accumulator, containing a sufficient quantity of oil under pressure will always be a desirable part of a large oil-burner plant.

The regulation of the burner, viz, the quantity of oil discharge, is had through difference of pressure. Thus, while the pump is set to discharge under a permanent pressure of 150 pounds, the oil inlet to each burner can be so throttled that discharge from burner is under 35 pounds only, thereby reducing the quantity to less than one-half of what it would be if discharging under 150 pounds. The throttling is done by a small valve in oil branch pipe to each burner.

The burner can be used with or without blast. Generally it will not be found necessary, and may even not be desirable to have blast; but where it is required the pressure need be but low, say from 1 to 3 ounces. A steam jet-blower or an ordinary fan-blower will furnish blast of suitable pressure, while the connecting pipe should be fitted with a gate for the the regulation, if there be an excess of pressure.

The quantity of the blast is not intended as a supply for combustion. It need be but sufficient for ignition, while a somewhat larger volume is not harmful.

The numerous devices in furnace construction, as second combustion chambers, providing for hot-air admission, and all improvements leading to perfect combustion or to maintain flame through long passages, apply with advantage to the burning of oil, equally as with coal firing.

The location of the burner depends entirely on the form of the furnace and the convenience with which it can be attached and operated. It may be fixed horizontal or at an angle with the direction of the flame, upward or downward, through the front, through the back, or through the side walls.

Where the flame has to extend through flues, as under cylindrical boilers, in heating furnaces, and under evaporating pans, a favorable direction of the flame is readily arranged. Where, however, the fire-box is short, as is the case in boilers of the locomotive and marine type, or upright tubular, it may be found desirable to direct the flame against a bank of fire-brick for better distribution.

In connection with the attachment of an oil burner to a furnace, particular attention should be paid to the location and volume of air admission. It is well understood that too large an admission, over and above that required for combustion, will cause a lowering of the temperature and a consequent uneconomical result.

There is one feature in the burning of oil, as in the burning of natural gas, of which we desire to make mention—the formation of a bank or cake of carbon at a point generally slightly in front of the flame. The amount of this carbon varies with different oils, as also with the arrangement of the furnace. Strange to say, this carbon does not burn in the oil furnace, while when taken out it is the very best fuel.

The reason for its formation is given in the fact that if unignited parts of oil strike hot fire-brick or other surface of certain temperature, carbon is deposited, while the remainder forms into a gas, which is burned. In long furnaces the formations will be less than in short ones, and while there is little or none with light oils, there will be more when burning heavier oils.

The Aerated Fuel Company's system.—This system consists in burning the oil with compressed air. The burner consists of a small cylinder, placed with its axis horizontal, and fitted with two inlets, one entering above a horizontal diameter, for air, and the other entering below for oil. The level of the oil is kept constant by a float attached to the valve which regulates the admission of oil. To this cylinder are attached the burners proper. They consist of two concentric tubes; the inner and smaller tube extends to within a short distance of the bottom of the oil chamber, while the outer and larger one opens into the air-space. The holes through the nozzle are only from one-twentieth to one-eighth of an inch in diameter and are regulated by a single valve. The air pressure maintained is from 10 to 25 pounds per square inch. Air being admitted into the air-space, and the nozzle-valve opened, a current is established and a spray of atomized oil and air is blown into the furnace. The oil being raised from the cylinder to the burner by pressure, as soon as the pressure is removed the oil drops back. The flooding of the furnace therefore becomes impossible.

This system has been very successfully used on shore, but in its present form would hardly fill the requirements of marine service.

Burner of the Petroleum Fuel and Motor Company of Washington.—

The apparatus as applied to a locomotive consists of the atomizer located below and secured to the floor of the cab; the oil-pump, drawing its supply from a closed tank in the coal-box of the tender and forcing it through the atomizer and pipes to the burners; the air-tank, and coil in the smoke-box for heating air, which is supplied by an ordinary Westinghouse air-pump, which pump also supplies the air-brake system; the superheating coil for superheating steam for the atomizer, which is located inside the fire-box; the burners, and the air-pipes for supplying air around and near the burners for the more perfect combustion of the atomized oil.

The atomizer consists of a hollow globular casting 5 inches in diameter and divided into two parts by a curved diaphragm. Through a nozzle on one side passes a pipe 1¼ inches in diameter which extends through the diaphragm and then narrows to a one-eighth-inch opening. In the interior of this pipe and having the same axis is a second pipe three-eighths inch in diameter and narrowing to a one-sixteenth-inch opening directly opposite the opening of the larger pipe. The superheated steam enters the globular part from below and passes through a number of small holes in the larger pipe and jackets the smaller pipe for a distance of 10 inches. The oil is supplied through the inside smaller pipe, being heated by the jacket, and passes in a jet through the one-sixteenth-inch opening, and then with the superheated steam passes through the one-eighth-inch opening in the end of the larger pipe. From the globular part, the atomized oil and superheated steam are conducted a distance of 20 inches through an inch and a quarter pipe, and then upwards to the post of the furnace door, and thence to the burners.

At the bend the hot-air pipe is attached, the heated air being delivered through a one-eighth inch pipe extending upward to the hollow door-post. The door-post is so arranged with a packed joint that the door can be opened and closed readily without deranging the oil apparatus.

The oil-pump is conveniently located within the cab at one side and arranged with a safety-valve and branch in its delivery-pipe, so that when the oil pressure exceeds the limit set the valve opens and the excess of oil flows back to the tank from which it was drawn.

The air-tank is a simple cylindrical drum to serve as a reservoir, and the heating-coil is of ordinary iron pipe, bent to form and set directly opposite the tube-ends in the smoke-box, so that the heat which it receives is only that which would otherwise be lost up the funnel.

The steam-superheating coil is located within the fire-box and rests on an inclined shelf of fire-brick, which shelf protects it as well as the tube-sheet and tube-ends from the direct action of the flame. A space over the top of the shelf, 8 inches wide, and at the sides and bottom 2 inches wide, permits the passage of the products of combustion to the boiler tubes.

The coil is of copper pipe 1¼ inches diameter with three-quarter inch bore. The pipes supplying both the air reservoir and the superheating-coil lead first to the cab, for the purpose of having regulating valves at hand, and then back to the coils, from which they lead directly to the atomizer.

The burners are placed on the lining-plate of the furnace door. The burners proper are 124 in number and are in the form of hollow frustrums of cones, three-quarters inch at base and one-quarter inch at the point with one-eighth inch openings, and projecting 1½ inches from the face of a flat casting. A second flat casting is faced and secured to the first one, and between the two is cut a spiral groove in which the pipe from the door-post, supplying the atomized oil, is placed. Drilled into this pipe opposite each of the hollow conical projections are 4 one-thirty-second inch holes, and the pipe itself terminates near the middle of the casting with a screw-plug, which can be removed for blowing through.

The air-supply pipes have bell-mouth openings, pass under the grates on both sides, thence up into the fire-box and entirely around and at a short distance in front of the burners. They are perforated on the side toward the flame. It is designed that these shall catch the air and force it up to the flame by the forward motion of the locomotive. A damper in the door performs the same office when the engine is backing.

All the pipes through which the oil, either in the liquid or atomized form, passes, as well as that for superheated steam, are of copper or of a composition of 90 per cent. of copper, and it is the use of this material, it is claimed, which prevents the deposit of solid carbon and consequent choking.

In the very successful trials of the torpedo-boat *Sunderland*, by Mr. Doxford, the boiler was of the locomotive type, the furnace being fitted with 31 burners of the Pyrigen class. When making her maximum speed of 21.03 knots only 21 burners were in use.

The following table of trial data will be found interesting, although no mention is made of the amounts of fuel burned or water evaporated:

Progressive trials of torpedo-boat Sunderland.

Number of run.	North or south.	Time. m. s.	Speed in knots.	Mean speed.	Indicated horse-power.	Mean I. H. P.	Revolutions per minute.	Mean revolutions.	Slip per cent.	Displacement.	$\frac{D^{\frac{2}{3}} \times S^3}{\text{I. H. P.}}$	Indicated thrust in pounds.	Boiler pressure. lbs.	Pressure in steam-pipe. lbs.	Pressure in first receiver above atmosphere. lbs.	Pressure in second receiver above atmosphere. lbs.	Vacuum. ins.	Temperature of feed-water.	Number of burners in use.	Compressed-air pressure. lbs.	Oil pressure. lbs.	Air pressure in inches of water.
1	N.	4 30	13.33	14.04	244	232.5	203	205.0	15.87	86	232.4	4,536	148	40	10½	−7	25	120	4	33	28	1¼
2	S.	4 4	14.75		221		207						160	42	13	−6½	24½	125	5	33	30	1¼
3	N.	3 57	15.19	16.03	486	472.5	250	247.5	20.50	86	169.7	7,636	157	70	28	−1¾	24½	120	6	35	30	1¾
4	S.	3 33½	16.86		459		245						153	70	28	−2¼	24½	125	6	35	30	1¾
5	N.	3 40½	16.33	17.37	652	648.5	273	274.5	22.27	85½	156.6	9,450	157	95	39	1½	24	125	9	35	30	3
6	S.	3 15½	18.41		645		276						159	96	41	2½	23¾	125	10	35	30	3¼
7	N.	3 16	18.37	19.53	961	969.0	316	316.0	24.09	85	148.4	12,266	158	135	60	8	24	100	15	35	30	4¼
8	S.	2 54	20.69		977		316						158	135	60	8	24	100	17	35	30	4¾
9	S.	2 55	20.57	19.56	1,001	973.5	324	316.0	23.95	84½	148.1	12,323	152	140	65	10	24	100	17	35	30	5
10	N.	3 14	18.56		946		308						148	140	63	9½	23¾	100	17	35	30	5½
11	S.	2 40	22.50	21.03	1,220	1,203.5	354	352.0	26.60	84	148.2	13,676	160	156	60	15	24	125	21	35	30	6¼
12	N.	3 4	19.56		1,187		350						158	155	70	15	24	125	21	35	30	6¼

It may be well to call attention to two grand divisions of the burners, those using steam for the injection of the fuel and those using compressed air. For marine purposes, where the loss of a pound of steam means the loss of a pound of fresh water, which has to be replaced by distillation, necessitating a distilling apparatus, and thereby adding weight to the machinery, the latter class appears to possess superior advantages, as the weight of steam used for injection purposes in the other type often amounts to 10 per cent. of the total quantity generated, and, unlike the steam used in the engine, it is not returned to the boiler.

2. COST AS COMPARED WITH COAL.

Dr. Charles B. Dudley, chemist, Pennsylvania Railroad Company, delivered a lecture before the Franklin Institute on the 6th of January, 1888, in which he said:

> The following table shows the relative heat-producing power of coal and oil. In this table the following assumptions are made: A pound of anthracite coal is supposed to contain 90 per cent. carbon; a pound of bituminous coal contains 85 per cent. carbon and 5 per cent. hydrogen; a pound of oil contains 86 per cent. carbon and 14 per cent. hydrogen, and the heat-producing power of the carbon and hydrogen in the theoretical part of the table is calculated by means of the well-known heat units of these two substances.

Relative heat-producing power of coal and oil.

	Pounds oil.		Pounds coal.
Theoretical anthracite	1	=	1.61
Theoretical bituminous	1	=	1.37
Urquhart's experiments	1	=	1.756
Peninsular Car Company	1	=	1.742
Elevated Railroad, New York	1	=	1.785

> It will be observed that Mr. Urquhart's experiments, which we may say are the result of a year's experience with the same 140 locomotives using coal and using oil, show that a pound of oil will generate as much heat as 1¾ pounds of coal. The experiments of the Peninsular Car Company, at Detroit, Mich., were made with Canadian petroleum in October, 1885, and show, as is observed, a very close agreement with Mr. Urquhart's figures. The experiments made on the elevated railroad in New York, were made during the summer of 1887. It is very interesting to note that experiments made in different countries, at different times and by different experimenters, should show so close a relation in the amount of heat-producing power of coal and oil, and it is perhaps safe to say in general, which is the figure that Mr. Urquhart uses mostly, that a pound of oil is as good for producing heat as 1¾ pounds of coal.
>
> The ratio of coal to oil having been obtained, we are in condition to begin to study the financial part of the problem, and it is clear that thus far the oil has the advantage, for every pound of it is as good as 1¾ pounds of coal. However, oil is usually bought by the gallon or barrel, while coal is dealt in by the pound or ton. It is plain, therefore, that in order to get a figure representing the cost of doing a certain amount of work, either by coal or by oil, we need to bring these measures together. Assuming, therefore, that a barrel of oil contains 42 gallons, that a gallon of oil weighs 7.3 pounds, and that 2,000 pounds is a ton of coal, we have the two following

formulæ, which will enable us to compute either the price that we can afford to pay for oil per barrel if we know the price of coal per ton, or the price of coal per ton to be equivalent to oil at a given price per barrel:

$$\frac{\text{2,000 multiplied by the price of oil per barrel}}{\text{Weight of oil per gallon} \times \text{No. gals. in bbl.} \times \text{ratio oil to coal.}} = \text{Equivalent price of coal per ton.}$$

$$\frac{\text{Weight of oil per gal.} \times \text{No. gals. per bbl.} \times \text{ratio of oil to coal} \times \text{price of coal per ton}}{\text{2,000.}} = \text{Equivalent price of oil per barrel.}$$

By the use of these formulæ, the following table has been calculated, and here it should be stated, that in actual practice it is found that there are certain economies where oil is used in addition to the economies in fuel account, notably saving in the cost of handling fuel and ashes, and economies in repairs to locomotives, especially fire-box repairs. This gives us two columns, one in which fuel account alone is considered, and the other in which all the ascertained economies are considered. As will be described in detail later, there are certain chances for economy in burning oil that do not occur with coal. Of these there have been pretty well worked out, as just stated, economy in handling coal and ashes, and economy in repairs to locomotives. The amount of these has been obtained in dollars and cents and is, perhaps, best expressed by saying that, taking all ascertained economies into account, a pound of petroleum is as good as 2 pounds of coal.

Relative value of coal and oil.

Oil per barrel at—	Fuel account alone considered. Coal per ton at—	All ascertained economies considered Coal per ton at—
$0.20	$0.74	$0.65
.30	1.12	.98
.40	1.49	1.30
.50	1.86	1.63
.60	2.24	1.96
.70	2.61	2.28
.80	2.98	2.61
.90	3.35	2.93
1.00	3.73	3.26
1.10	4.10	3.59
1.20	4.47	3.91
1.30	4.85	4.24
1.40	5.22	4.56
1.50	5.59	4.89
1.60	5.97	5.22
1.70	6.34	5.54
1.80	6.71	5.87
1.90	7.08	6.19
2.00	7.45	6.52

It should be remembered in making all calculations as to the relative cost of coal and oil for heat production, the two must be taken in the same situation. It would be obviously incorrect to take the price of oil as quoted in the daily papers, which means the oil in the pipe lines or in the storage tanks in the oil regions, and compare it with coal in Philadelphia, which has already been transported from the coal regions to this point. The two must be compared in the same situation, and if the ratio of 1 pound of oil equals 2 pounds of coal is considered, the prices must be compared with the fuel ready for use, either on the locomotive tender, or in the tank at the stationary boiler. The formulæ and the table will enable every one to make the comparison for themselves for their own locality. It will perhaps be somewhat surprising to those who have not made some calculations on this subject to note that oil at 3 cents per gallon is considerably over $4 per ton for coal, and also to know that at present prices even crude oil at Philadelphia is difficult to be had at 3 cents per gallon.

The following reports on the relative cost of oil as fuel were made at the convention of the National Electric Light Association, by Mr. M. J. Francisco:

The Boston and Albany Railroad Company, after a careful test made in their shops by a Lehigh University professor, say that the cost of fuel is about the same. Though they purchase their coal in large quantities at one time and secure low rates, they prefer liquid fuel, because it is clean and requires no firemen, and gives a better supply of steam.

Day, Cordage & Co., of Boston, claim that with Cumberland coal at $4.50 per ton and liquid fuel at $1.15 per barrel, they save 15 cents per 100 horse-power per hour, and the oil is preferable.

The Fairbanks Scale Company, of Vermont, report that they find it a great saving over coal, while the boilers are heated evenly the entire length; also that the insurance companies have not increased their rates.

T. P. Brown, manager of the Toledo, Columbus and Southern Railway, reports a saving of 33 per cent. of the price of coal by using liquid fuel; also that 2 barrels of oil equals 1 ton of soft coal, while manufacturers on his road find it only costs one-half as much as coal for their stationary boilers.

Mr. G. H. Billings, of Boston, in a report to the mining engineers, made at the meeting in New York in 1889, after showing the large saving in using coal rather than oil in puddling, says in regard to the use of oil for raising steam:

The following is the record for the first day, starting with everything cold: We used 2,910 pounds of oil to evaporate 15,600 pounds of water. One gallon of oil weighs 6.328 pounds, and 2,910 pounds of oil would equal 459.86 gallons, which, at 4⅞ cents, is $22.42 (for ten hours). As these boilers run night and day, twenty-four hours, at $22.42 per shift, would cost $53.81, and three hundred days, or one year, would cost $16,143 under one boiler. As we have three boilers, the expense of using oil would be $48,429 per annum. Assuming 1 pound of coal would under the same circumstances evaporate 9 pounds of water, it would take to evaporate 15,600 pounds of water 1,733.33 pounds of coal; this at $4.875 per ton, or .00217 per pound, would cost $3.76 for ten hours. For twenty-four hours, at .376 per hour, it would cost $9.024, and for three hundred days, or one year, it would cost $2,707.20, the expense for one boiler. For three boilers, it would cost $8,121.60, thereby showing a saving of $40,307.40 by using coal instead of oil.

On the second day the furnace was hot (having run the previous day). The results were: We used 4,156 pounds of oil to evaporate 27,600 pounds of water. One gallon of oil weighs 6.328 pounds, and 4,156 pounds of oil equal 656.76 gallons, at 4⅞ cents cost $32.01, the amount used for ten hours. As these boilers are run night and day, twenty-four hours, at $3.201 per hour, equals $76.82 per day, or at three hundred days per year the cost of using oil under one boiler would be $23,046. As we have three boilers, the expense of using oil would be $69,138 per annum. Assuming 1 pound of coal would under the same conditions evaporate 9 pounds of water, it would take to evaporate 27,600 pounds as many as 9 is contained in 27,600 pounds, or 3,066.66 pounds of coal, costing $4.875 per ton, or $0.00217 per pound, by 3,066.66 equals $6.65 for ten hours, or for twenty-four hours, at $0.665 per hour equals $15.96 per day, or at three hundred days per year the cost of using coal under one boiler would be $4,788; under three boilers the expense of using coal would be $14,364, which subtracted from $69,138, the cost of oil, leaves $54,774. Therefore, we show a saving of $54,774 per year by using coal instead of oil.

Mr. Billings does not mention the method used for burning the oil, but it must have been a very crude one, as only 5.36 and 6.64 pounds of water were evaporated per pound of oil on the first and second days respectively.

It will also be noticed that the cost of the fuel alone is considered by Mr. Billings. In the following report, made at the same meeting of the mining engineers, by Mr. E. C. Potter, the cost of the labor required under the two systems is included:

Fuel oil was first substituted for coal at the South Chicago Works of the North Chicago Rolling Mill Company, in September, 1888, and was first applied to the battery of boilers in the converting department. This battery consists of 14 tubular boilers, 15 feet in length by 5 feet in diameter. To operate these boilers with coal the following men were required for twenty-four hours: 14 stokers, 3 ash wheelers, 6 men unloading coal, 2 water tenders, making a total of 25 men. With fuel oil the following men are required to operate the same boilers: 2 water tenders and 4 men to attend to the burners, making a total of 6 men. This gives a saving of 19 men by the use of fuel oil in place of coal, which, at an average price of $2 per day each, would give a saving of $38 per day. Comparing the consumption of fuel oil with that of coal, we find that for the week ending January 5, 1889, with an ingot output of 6,403 tons, 2,731 barrels of fuel oil were used as against a necessary consumption of coal for the same work of 848 tons, showing 3.22 barrels of fuel oil to be equivalent to 1 ton of Indiana block coal. Figuring oil at 60 cents per barrel and coal at $2.15 per ton, we have the cost of oil, $1.93, as equivalent to coal at $2.15, making a net saving of 22 cents per ton.

In December, 1888, the rail-mill battery of 26 boilers, of the same dimensions as those in the converting department, was equipped for fuel oil. For the week ending January 5, 1889, with a rail output of 5,208 tons, 5,987 barrels of oil were consumed as against a necessary consumption of coal to do the same work of 1,805 tons, showing 3.31 barrels of fuel oil to be equivalent to 1 ton of Indiana block coal, which, with the costs named above, would show $1.98 worth of fuel oil to be equal to $2.15 worth of coal. The labor required to operate the rail-mill boilers for twenty-four hours is as follows with coal as fuel: 26 stokers, 4 water tenders, 6 ash wheelers, 12 men unloading coal, making a total of 48 men. With oil as fuel the following men operate the same battery for twenty-four hours: 4 water tenders, 6 men to attend to the burners, making a total of 10 men, a saving over coal of 38 men in twenty-four hours, which, at an average price of $2 per day, would be $76 per day.

With the brief experience we have had with oil as fuel we find that the efficiency of the boilers is somewhat increased and the repairs materially lessened. The perfect cleanliness of the fuel and the ease and simplicity of supply and regulation, together with the steadiness and uniformity of steam supply, make it, for our business at least, a most desirable substitute for coal.

We have made no evaporation tests of any kind, the only test of its efficiency being the fact of its keeping our works running to their fullest capacity. This we find it will do, which can not be said to be true of coal with our present boiler capacity.

From the report of Mr. E. C. Felton (meeting of the mining engineers) we abstract the following:

Sixth trial.—Raising steam under two return flue tubular 100 horse-power boilers. The best twelve hours' work showed 16 pounds of water evaporated by 1 pound of oil; the average was about 12 pounds water per pound oil, the temperature of the feed water being about 160°. The use of oil is not so economical as pea coal.

During the discussion which followed the three preceding reports Mr. R. W. Hunt, of Chicago, stated:

* * * That when he was in charge of the Troy works an experiment was made with the Hayden apparatus for burning oil. One of two Swindell furnaces was fitted up with it, while a second furnace, identical in construction and in capacity, remained unaltered. Both were serving an 18-inch mill. The petroleum used cost 4½ cents at that time, while the Westmoreland coal cost $4 per ton. Records kept over a period of three months under practically identical conditions showed that if oil could be had at 3 cents a gallon there would be a saving of 50 cents a ton.

Mr. J. M. Sherrerd, of the Troy Steel and Iron Company, referred briefly to the experiments being made at that plant, conditions having considerably changed:

The use of oil has been eminently successful in Troy in connection with its use to fire the boilers of the furnace plant when the gas supply happens to be inadequate. Under these conditions oil possesses the great advantage of responding quickly at a time when a prompt supply of steam is particularly needed. Mr. Sherrerd stated that the entire oil consumption for the blast-furnace boilers was 1,500 gallons in a month, in which time the furnace produced 5,900 tons of pig-iron.

The president, Professor Potter, stated that experiments at a large works in St. Louis had shown that oil at 3 cents, the price then ruling, is equivalent to $2 coal; but as coal costs $1.37½ delivered, oil is too dear to use. In some instances, where cleanliness and a clear fire are particularly desirable, oil is preferred. Thus the St. Louis Shovel Company have adopted it for their forges.

Mr. Urquhart, locomotive superintendent, published some time ago the results of working with coal and petroleum residium on the Grasi-Tsaritzin Railway, where the latter has been the sole fuel used since October, 1884. The comparison is accurate, complete, and comprehensive, and is the result of a year's use of each article. The following is an abstract of the results:

	6-wheeled engines.	8-wheeled engines.
Average consumption of coal per mile, 1882 .... Pound..	57.25	81.43
Average consumption of petroleum per mile, 1885 .... do....	32.23	46.63
Saved on petroleum against coal in weight........ per cent..	43.70	43.68
Unproductive run of locomotives:		
With coal in 1882, per cent. of aggregate	35.25	15.85
With petroleum in 1885, per cent. of aggregate	36.08	15.97
Average cost per mile:		
With coal	$0.158	$0.23
With petroleum	$0.08	$0.13
Saved on petroleum against cost on coal .... per cent..	42.35	43.13

The Railroad and Engineering Journal, in reviewing the trials of the Urquhart system on the Pennsylvania railway, says:

Carefully made experiments and the chemical composition of both coal and oil show that the heat-producing power of a pound of petroleum is equal to that of 1¾ pounds of coal. If the saving due to the cost of handling fuel and ashes, and the diminished repairs to the fire-boxes of locomotives, is taken into account, it is found that 1 pound of oil is equal in value to 2 pounds of coal. A gallon of oil weighs 7.3

pounds, and a barrel contains 42 gallons. From these data it is easy to calculate the prices at which coal and oil are equally cheap. The following table has been calculated in this way:

Price of coal per ton.	Price of oil per barrel, to be as cheap as coal.
$2. 50	$0. 68½
2. 75	. 75½
3. 00	. 82½
3. 25	. 89½
3. 50	. 96½
3. 75	1. 03½
4. 00	1. 10½
4. 25	1. 17½
4. 50	1. 24½
4. 75	1. 31
5. 00	1. 38

This showing does not look very promising for the general use of petroleum for fuel in this country, as any considerable demand from this source would undoubtedly put the price up, unless the production is largely increased over what it is now.

Mr. I. M. Sowers, of the Standard Oil Company's fuel oil department, Chicago, in a statement recently made in regard to the use of fuel oil in the Northwest, after mentioning by name thirty-two large manufacturing firms in or near Chicago which use it, says:

Although soft coal is very cheap in Illinois, it has been found by manufacturers that crude oil can not only be had at competitive prices, but that even where the initial cost is greater there are advantages in the use of the liquid fuel which almost compel its adoption. It is smokeless, for the fine spray of oil which comes from the injector consists of such minute drops of the liquid, and is so thoroughly mixed with oxygen, that when it burns the combustion is complete, and only steam and carbonic acid gas go up the chimney. Not a speck of soot comes from the smoke-stack or soils the whitewashed purity of the boiler-room. It is absolutely clean. It is labor saving too. No fireman has to keep shoveling coal, the flues do not have to be cleaned every week or so, there are no ashes to be dragged out from under the furnace, and there are no clinkers to clog up the bars. One man by turning a valve may regulate the heat of a battery of 15 boilers. In the McCormick Harvester Works the forge fires are not covered with hoods to draw off the acid smoke of burning coal as in the old days. The fires are open and there are forty of them white hot, as white as an arc light, without a trace of smoke. One man can make nearly four times as many welds in a day by one of these forges as he could when they used coal fires. This is the invariable testimony of other consumers of petroleum fuel with whom the subject has been discussed. At one time the insurance companies objected to its introduction in certain establishments and localities, and the Chicago authorities were also hostile to its use in the city, lest it might prove dangerous, but all the objections have been overcome as indicated by the long list of Chicago consumers.

The use of fuel oil in the Northwest has been greatly assisted by the enterprise of the oil producers in piping oil from the wells at Lima, Ohio, to South Chicago. A system of storage tanks has been established on a large scale, so that consumers can be supplied for an indefinite time in case of an accident to the pipe line. The oil is delivered by tank cars from South Chicago to points in the Northwest. The Chicago price is 70 cents per barrel of 42 gallons, and it is estimated that a barrel and a half of oil equals a ton of coal in heat producing power.

3. SAFETY IN STOWAGE AND USE.

Under this head we can not do better than quote entire the abstract of Herr Busley's article which appeared in the Engineer of July 13, 1888.

The best directions for the storage of liquid fuel on board ship will be found in the regulations issued by the Russian Government for the heating of steamers of the Caspian Sea with mineral oil residuals. Suggestions may also be gathered from published descriptions of arrangements that are now made on board ship for this purpose, petroleum being no longer stored in casks, but carried across the ocean in specially built vessels.

In treating this subject we must take into consideration (*a*) the circumstances that must be kept in view in the construction of oil bunkers; (*b*) the construction and arrangement of the bunkers; (*c*) precaution against explosions.

(*a*) *The factors to be kept in view in the construction of oil bunkers.*—Whereas oil has hitherto been stored on board ship in separate receptacles, the weight of which was very considerable, it has been proved that in the case of modern tank ships petroleum can be stored in bunkers as easily as coals, if the following factors are kept in view: (1) The expansion of the oil with every rise of temperature; (2) leakage through the seams; (3) the separation of the water which is always present in the oil; (4) the effect on the stability of the vessel produced by the gradual emptying of the bunkers; (5) the carrying off of the gases given off by the oil; (6) keeping the oil away from heating surfaces; and (7) warming the oil in time of severe frost.

(1) The expansion of the oil by every rise of temperature, which may be occasioned by the radiant heat of boiler fires, as well as by the tropical heat of the bunkers themselves, is very considerable. The coefficient of expansion of the different oils varies, according to experiments made by St. Clair Deville, from 0. 0007 to 0. 0009, so that a rise of temperature of 22° to 23° C. suffices to create an increase in the volume of the oil of from 1.5 to 2 per cent. If the bunkers then should be fully charged at the commencement of the voyage, they must be fitted with such an appliance as will enable them to be enlarged or reduced according to the rise or fall of the temperature.

(2) Leakages occur through the peculiar tendency of the oil to ooze through seams and joints that are perfectly water-tight. This peculiarity, however, is less marked in the case of thick or coarse oils, and is consequently not so great in residuals as in the oil itself. In the case of the latter, the loss in cargoes sent in barrels is estimated at 2 per cent. In bunkers, where, in proportion to the volume of oil, a much smaller seam is requisite, this loss, especially when the caulking has been carefully carried out, is very much less. We may, therefore, assume that the leakages of the oil residuals in bunkers do not attain greater proportions than about 1 per cent. of its entire weight.

(3) The separation of the water from the oil during its storage in the bunkers is absolutely indispensable, with a view to the avoidance of interruptions in working, such as the extinction of the gas flame, as well as the prevention of loss of heat. This water gets mixed with the oil either from atmospheric depressions during carriage on the railway, or else through its admission by accident on board lighters, etc.

(4) The effect on the stability of the vessel, especially in the case of well-fitted cross-bunkers, may be very dangerous. If a certain depletion of the bunker be taken for granted, it will be seen that the rolling of the ship must cause the displacement of the oil.

(5) It is absolutely necessary to carry off the gases generated in the oil by heating and agitation, which spread themselves along the surface of the oil, otherwise there is considerable danger of fire or explosion.

(6) It is, for the same reason, of equal importance to prevent any oil that may have oozed through the sides of the bunkers from getting near the furnaces or the heating

surfaces. But, apart from this, the smell of the constantly dribbling oil evaporating near the fire-boxes would very quickly become unbearable for engineers and stokers.

(7) In case of severe frosts or in voyages in high latitudes it is imperative to keep the oil warm, so as to maintain it at a sufficient state of thinness; otherwise its density would become too great for practical use, and for this reason the oil should always be kept at a temperature of 12° C. By this means water, as well as all other foreign substances, is easily separated from the oil.

(*b*) *The construction and arrangement of the bunkers.*—The above considerations, as well as the regulations of the Russian Government already referred to, enable us to make the following rules for the construction of oil bunkers:

(1) Wood must not be used for the walls, floors, or covers of the bunkers, as it is too combustible a material.

(2) New vessels that have to be fitted at once with oil bunkers must have double partition walls fitted to all those parts bordering the engine and boiler space. It would be advisable to keep the spaces between these partitions filled with water, or, at any rate, to have a collecting tank at their deepest points, so that any oil which may ooze out of the bunkers and find its way there may thus be collected and pumped out at intervals. Any gases that might form in these spaces where they are not filled with water should be cleared out by a steam ejector. No sluice valves or other openings should be fitted to these partition walls. In fact, every precaution should be taken to prevent the oil getting into the boiler and engine space.

(3) The shell and double bottom can, in the case of new ships, be turned into the immediate boundaries of the oil bunkers when they are well riveted at these places like boilers, and after they have been subjected to a cold-water test of a pressure double what they will later be exposed to. This, according to Swann, is the method adopted by Messrs. Armstrong for their ships. As an example of a riveting for an oil ship by Messrs. Gray & Co., of West Hartlepool, the following data will be useful: The inner double bottom, which forms the lower boundary of the oil bunker, had tin-plates that were 15^{mm} thick, the rivets were 16^{mm} in diameter, and stood 57^{mm} apart. The shell tin-plates were 16 to 17.5^{mm} thick, and the rivets were 22^{mm} in diameter, and were in the longitudinal rivetings 63.5^{mm} and 70^{mm} and in the cross-rivetings 70^{mm} and 76^{mm} apart. Where rivets of 19^{mm} were used they were 60^{mm} to 63.5^{mm} apart. The rivets between the knees and skin were 152^{mm} and 165^{mm} apart. The overlappings in the cross-partitions were riveted with rivets 16^{mm} thick with a distance from each other of 57^{mm}. Such close riveting, combined with good fitting together of the rivet holes—which were probably punched on the spot—careful riveting, and stopping up of any interstices, are a guaranty of oil tightness.

(4) The decks, insomuch as they are the boundaries of the bunkers, must be of sheet-iron, and must be riveted as securely as the skin and the bottom. We recommend, should the deck be planked, to place a layer of felt or cement on the iron, and to coat the planks underneath and along the sides with lime or varnish, so as to prevent, if possible, their being saturated with oil. It is, however, safer to omit planking the deck. In the place of the ordinary coal-holes, man-holes should be cut in the bunker-decks.

(5) The old coal-bunkers, although they may be water-tight, can not be used as they are, for oil-bunkers. They must be fitted all round with a carefully-riveted double wall. In other words, carefully-constructed tanks have to be built into them for the reception of the oil.

(6) All bunkers must be fitted with self-acting filling appliances, so that they may be kept full until their contents are wanted for fuel. As we have already stated, a certain contraction of the oil takes place on lowering of temperature. Besides this, a certain quantity of oil keeps oozing through the shell into the water, although the water can not possibly get into the ship through the careful riveting. During bad weather the oil in one of these partially empty bunkers becomes much agitated and strains the ship to its utmost, until at last it succeeds in escaping in large quantities through the loosened communications. These disadvantages have to be overcome by

keeping the bunkers continually full by means of an oil-tank situated above them, which communicates with them either together or separately. This tank does not only replace the losses occasioned by leakage and diminution of volume, but receives the expanding oil in the case of a rise of temperature as well. The lower the liquid level in this tank the less is it likely to influence the stability of the vessel. Cylindrical erections in the bunkers reaching to the next deck and containing a proper quantity of oil are the best.

(7) Cross-bunkers, should they be required, must be partitioned with two or three sections, so that when they are getting empty they may, by change of oil level, reduce the stability of the ship as little as possible.

(8) Every bunker must be in communication with a ventilating pipe at its highest point. This pipe must be either separately, or after its union with a main pipe composed of numerous such branch pipes, led on deck, and there carried to a considerable height as a ventilating pipe. To prevent an explosion of the gases as they stream out of this pipe its mouth must be covered with wire gauze. The suction pipe of the steam-pump must be laid to a deep point in the bunker. This pipe conducts the oil into the tanks above the furnaces, from whence it flows into the sprinkler. Each bunker must, besides, have a pipe for filling itself with.

(9) Every bunker must have a collecting tank for the water which gets separated from the oil. This must be in communication with a Lenz pump or an ejector.

(10) A steam-pipe must be laid through the bunker for the purpose of keeping the oil warm and separating the water from it if the vessel be intended for high latitudes.

(11) The carefully coated boilers must be at least 45^{cm} from the wall of the bunkers, so as not to warm them too much.

(12) The bunkers must be provided in their lower parts with oil-level gauges, so that their emptiness can be easily discovered.

(*c*) *Precautions against explosions.*—The frequent explosion of the oil, especially on board the steamers of the Caspian, was at first attributed to spontaneous combustion when they really owed their origin to the inflammability of the oil, and particularly to carelessness. According to the investigations of Boutleroff and Sinin, spontaneous combustion of mineral oil is impossible, inasmuch as it does not condense any gases on its surface, and none of its components take up the oxygen of the air; on the contrary, they are all opposed to oxidation. It is only when very inflammable bodies are present, such as sawdust, cotton wool, etc., which are completely saturated with petroleum, that spontaneous combustion becomes at all possible. To avoid this danger, which the great inflammability of the oil entails, the Russian Government has prohibited the use of such mineral oil on board ship as shall have a point of ignition lower than 70° C., for the temperature of the oil in the bunkers frequently exceeds 60° C., owing to the heat radiated by the boiler in addition to the heat of the sun.

This prohibition only touches the undistilled mineral oil. The residuals after the first distillation, as well as the other heavy oils used for fuel, have an ignition point of 100° C.; Goulischambaroff, however, is of the opinion that even undistilled oil can be used as fuel, so long as the evaporation of its volatile particles is not left out of sight; and this view is indeed justified by practice in the United States, where, in all trials of liquid fuel, the undistilled oil has always been used.

The precautions to be observed in using oil as fuel turn on this point, namely, that the oils themselves are not to be feared, but only the explosive gases formed by the admission of air; and even these only when they are brought into contact with an open flame. If the bunkers, therefore, are provided with shafts to carry off these gases, and if when they are empty they are carefully aired, and then only inspected with safety lamps, all elements of danger have been eliminated, especially if the fuel used is residuals, which have scarcely any gases left to evaporate. In this case it may be safely stated that there is less danger of explosion than in cases where coal is actually fuel. When, however, as Russian enginemen with remarkable carelessness have actually done, half empty bunkers are lighted up and examined with unprotected open hand lamps, bad results are almost inevitable.

In the engine-room of all Russian oil-burning steamers a notice is put up which points out the danger of inspecting bunkers with open hand lamps, and insists on having all bunkers emptied and aired before they are examined and entered. The Russian Government engineers are responsible for the carrying out of all the Government regulations with reference to the use of liquid fuel on board steamers.

Some idea may be formed of the danger of a mixture of petroleum vapor and air when it is stated that 1 gallon of petroleum spirit is enough to render 16,000 gallons of air inflammable, in other words, the air contained in a space the size of a 500-ton coal-bunker. This vapor is very penetrating and of a high specific gravity and flame-carrying power, rendering the presence of even a small quantity extremely dangerous.

Even with care accidents will happen. In the case of the S. S. *Fergusons*, fitted with electric lights, an explosion occurred through faulty insulation. The Nautical Magazine, in its review of Mr. George Herbert Little's work on the Marine Transport of Petroleum, says of this accident:

This vessel is fitted up with tanks built in and distinct from the hull, and had discharged a cargo of crude petroleum which had been shipped at Philadelphia. One of the crew went below to shut the cocks in the filling and discharging pipes, having with him a portable electric light. An explosion occurred and the man was never seen again. Dr. Dupré, who gave evidence at the inquiry, said he had seen a model showing the manner in which the wires of the portable electric lights were connected to the main cables, and in his opinion it would be difficult to avoid sparks arising from the electric lighting arrangements, and sparks would be quite sufficient to fire the explosive vapor. In this instance the element of designing the tank arrangements had considerable to do with the disaster. No vessels are now converted for the oil-in-bulk trade as the *Fergusons* was, but it is also evident that even with electric light there is not necessarily an immunity from explosion. In our limited space we can not indicate all the precautions necessary to an efficient system of the electric lighting of petroleum vessels, but one of the most important details may be noticed. In such vessels, instead of the single wire system, with the hull of the ship as the return lead, the two-wire system should be adopted, and although more expensive in first cost, it is probably in all cases the cheapest in the end. Often with the single wire salts form on the joint between the lamp wires and the ship's skin and introduce an electrical resistance, causing the lamps to burn dimly and unevenly; and there is great trouble in testing such currents and localizing defects. Having in view the *Fergusons* disaster, it is also important that all the flexible leads for hand lamps, etc., should be additionally protected with a sewing of spun-yarn, as petroleum tends to soften and destroy the insulation.

Attention is called to the fact that the fumes of petroleum produce on many people the effects of intoxication, and therefore, for the prevention of accidents from this cause during the process of cleaning the tanks, some one should be stationed on deck to give the alarm in case of necessity.

4. ADVANTAGES AND DISADVANTAGES.

Again quoting from the Engineer:

All the advantages of liquid fuels compared to coal, especially those that are of weight in connection with modern fast steam men-of-war, are easily enumerated, as follows:

(1) The rapidity and cheapness with which they can be brought on board, which, according to Tweddell, are so great that the steamers of the Caspian can ship from 800 to 1,000 tons of fuel in from three to four hours, a period which could be still more reduced if a few arrangements, still wanting, were introduced. A torpedo boat, therefore, which required at most about 20 tons of liquid fuel could be made ready in a few minutes, and a whole flotilla would require no more time than it takes to coal a single boat at present.

(2) The storage of the oil in such parts of the vessel as are unfit for cargo. Such parts are the water ballast tanks of large cargo carrying steamers, the double bottoms of ironclads, as well as the keel spaces fore and aft of boilers and engines on all steamers. Besides, by filling up these spaces it will become possible to make the engine rooms more convenient and spacious, by reducing the bunkers, especially in the case of smaller vessels.

(3) The diminution of the staff of stokers and of the physical fatigue of stokers. As the oil is sent out of the bunkers into tanks above the furnaces by means of a steam pump, from whence it flows of itself into the furnaces, coal trimmers are not required. Besides, only one stoker is wanted for each watch for every furnace on board, who has to regulate the sprinkler taps and see that the water in the boilers is at the right height. Tweddell says that the steamers of the Caspian have usually only one stoker and two boys for each watch. The largest steamers that have communicating furnaces would therefore require no more than one stoker and 3 or 4 boys for each watch, and would therefore want no more than 3 stokers and 10 or 12 boys altogether, whereas at present they require a staff of stokers amounting to from 60 to 80 men, which must cost steamship companies at least $300 per annum per man in wages and keep. What sums steamship companies would save through reducing their stoking staff can be easily calculated. On board torpedo boats one stoker would suffice instead of the two that are the rule now for each watch; and as the stoker will have little physical work to do, the men will keep better health in bad weather, whereas at present it is well known that the leading stokers are the first to get exhausted.

(4) The greater power of evaporation of liquid fuels, which is in proportion of 7 to 4 to that of coals, enables steamers either to reduce the weight of the fuel they take on board when the same distance is to be steamed, as in the case of coal fuel, or else enables steamers to steam a longer distance when the same quantity of liquid fuel is taken as would have been required if coal had been used. A modern torpedo-boat, which, for example, at a given speed could go 4,000 knots, would, if instead of coal it had the same weight of oil on board, be able to go 7,000 knots, and if it filled an equal space with oil as the coals would have occupied, it would be able to go 7,500 knots, because 1 ton of coal occupies 1.25 cubic metres on board, whereas 1 ton of oil residuals occupies 1.11 cubic metres. By means of liquid fuel therefore the sphere of action of a torpedo-boat can be nearly doubled.

(5) The more perfect combustion of liquid fuel prevents the formation of residuals and smoke. Consequently ashes and cinders do not occur, and the furnaces need not be cleaned, nor need the flues be swept. The first circumstance is of the greatest importance with regard to torpedo boats, which generally have only one furnace, the grates of which after a six hours' coal fire, at most after ten, are covered with clinker. It then becomes imperative to clean the grates if the same steam pressure and speed are to be kept up. Such a cleaning is not, however, easily accomplished. The grate surface is generally about 2 metres square, on which during ten hours about 8 tons of coal have been burned, leaving, even under favorable conditions, at least 80 to 100 kilograms of clinker. Besides during the operation of cleaning the boat must lose a considerable amount of speed, owing to arrested evaporation. A further loss of speed is incurred by the attachment of "swallows' nests"—rings—to the mouths of the tubes, and as the grates must be cleared at short intervals—especially if the journey is rapid, for the grates can not be kept free of clinker—it is clear that a vessel chasing a torpedo-boat may easily overtake it without attaining as great a speed as the latter,

for her fires can be cleaned at each watch, and she need not therefore lose so much speed. If the torpedo-boat, however, should burn liquid fuel instead of coal it can go on for days without rest or loss of speed and must necessarily distance any larger craft chasing it. But there are two other important factors that have not even been taken into consideration. The first is the advantage that is derived from doing away with the very cumbersome and filthy process of throwing the ashes and cinders overboard, which is even quite impracticable during action, and the second the immunity from exposure to a singeing of clothes and body by sparks and cinders flying out of the short funnel when the speed is at all rapid. People who have been any time on board a torpedo-boat can certainly have no very pleasant recollections of their experience. On the other hand the abolition of smoke is of the greatest tactical importance. The torpedo-boat that does not betray itself by a column of smoke is very difficult to discover on the horizon, and will, therefore, have an enormous advantage, as it will itself be able to distinguish all larger vessels by their smoke columns. How these masses of smoke issuing from the chimneys, even though the best coal be used, betray the movements of vessels when a sudden increase of speed is laid on and artificial draft applied the English naval authorities have had brought home to them during last year's naval manœuvres. As, however, a sudden stoppage of the air current will produce enormous dense smoke columns in cases where liquid fuel is used, Captain Curtis, R. N., has suggested that this circumstance should be utilized with a view to establishing a code of smoke signals for long distances on the Morse system.

(6) The improved ventilation of the firing space, which is said to be caused by the admixture of air in the sprinkler, and also by the fewer rays of heat. According to Tweddell, if one goes below into the engine-room when the thermometer is 40° C. in the shade, an increase of temperature, as compared to that on deck, is scarcely noticeable when oil is the fuel; whereas with the coal fires, with natural draft, the temperature rises under similar conditions to 55° and 60° C. Besides, in the former case the stokers need not exert themselves at all, whereas where coals are used they have to work very hard, and must come on deck every few minutes to get a breath of air. For tropical climates, therefore, liquid fuel is strongly to be recommended.

(7) The greater manœuvring capacity of the engines, which is attained by the possibility of suddenly increasing, reducing, or stopping the fire. In the case of coal fires, if it be desired suddenly to shut off the steam, and the safety-valve is not to be used, the fire and smoke-box doors have to be opened and the cold air must be admitted directly into the boiler, which is exceedingly bad for the latter. Further, a considerable time must elapse before a fire thus extinguished can be made to burn again. But both can be quickly accomplished in the case of sprinklers by simply closing or opening the steam and oil valves.

(8) The longer life of the boilers, which is chiefly to be ascribed to the fact that the fire-doors need only be seldom opened, and consequently the entrance of cold air into the furnace, and the resultant cooling of the boiler-plates, are completely avoided. It is perhaps of less importance that mineral oils contain no sulphur, and consequently the plates of the fire-box are not so severely taxed as in the case of coal, the sulphur of which, owing to the formation of sulphurous acid, acts destructively on the iron.

(9) The ease and exactitude with which the oil can be measured when it is taken on board, as well as when it is being burned, should silence complaints of short weight in coals, which one hears so frequently now, and should also insure a better verification of the consumption of fuel during trial.

Those advantages, of which 3, 4, and 5 are the most brilliant, must be considered in connection with certain disadvantages which the use of liquid fuels entail, and which can not be passed over. These are:

(1) The erection of oil-tanks and supply-pipes in the place of existing coal stations, so as to insure the rapidity of taking oil on board, alluded to above. These oil stations need not be so numerous, however, as the coal stations, because steamers burning oil do not require fueling so frequently as those that use coal. The cost of erec-

tion and maintenance of such stations, with good oil-tight iron trucks, with pumping machinery for filling, as well as a system of supply-pipes for emptying them, by means of which as many vessels may be served at one and the same time as feasible, would probably not exceed the expenditure on coal stations, which must be provided with sheds in good repair, lading jetties, tipping appliances, etc. The staff of workmen, on the other hand, would be remarkably small at an oil station, as compared with the number required at a coal station, for the transmission of oil can be worked mechanically, whereas the transport of coal must of necessity entail a great deal of manual labor. If the tactical advantages of liquid fuel be considered of sufficient importance, the slight additional expenditure in oil stations will not stand in its way.

(2) The loud noise occasioned by sprinklers, which is exceedingly inconvenient in the case of passenger steamers, would be fatal for torpedo-boats. If it is realized, however, that this noise, according to d'Allest's experiments, resembles strongly that of a large fan, and as the fan engines fitted to torpedo-boats which use artificial air currents do not work particularly noiselessly, it will be admitted that the difference is not very great. Besides, a torpedo-boat making a night attack would travel very slowly so as to avoid all possible noise, and a sprinkler worked with a pressure of 0.5 atmosphere makes very little noise indeed, according to French experiments, and it is very probable that even this slight noise would be lost in the general noise of the pumps and engines.

(3) The combustibility of the oil, which might occasion an explosion in the event of a shell hitting the tanks. This objection may be met by the statement that the oil can be easily stored under the water-line, where it would be comparatively safe. Besides which it will yet have to be proved whether oil in a tank is really likely to ignite if pierced by the splinter of a shell. Of course all idea of getting protection out of the oil tanks, as in the case of coal bunkers, must be relinquished, but this sacrifice is not so great as would at first appear. The very thin bunker walls and the far from thick layer of coal that surrounds the boiler at present can scarcely be seriously regarded as much protection against the penetrating power of modern projectiles and shells. Nor should we forget that Admiral Selwyn is not in favor of using oil that has a lower specific gravity than from 1.050 to 1.060, therefore possessing a higher specific gravity than sea-water—1.026. The advantages of such oil is self-evident. The dense, heavy oil is less easily ignited, contains no volatile gases, and burns more economically on account of its density than thin oil, and does not flow off into the sea at once as soon as the tank under water-line has been pierced by a projectile, as is the case with the lighter oils. The remaining oil could in such circumstances be still used for fuel, while the water that had entered through the aperture made by the projective could be allowed to remain floating on the top; and as it would be lighter than the oil it had replaced, the buoyancy of the vessel would be increased instead of being reduced. A coal bunker that has been riddled must, on the other hand, be instantly shut off. Its contents are no longer of any use, and the water that enters it reduces the buoyancy of the vessel.

(4) The very small number of oils that can be used as fuel. If estimated at a maximum, the annual output of all the natural oil of the world amounts to about 6,000,000 of tons of mineral oil, 750,000 tons of tar-oil, and 250,000 tons of slate or shale oil—altogether 7,000,000 tons. Modern industry, which transforms these into liquid fuel, lubricating oils, benzol, paraffin, etc., can not spare them; at most it can leave us about 20 per cent. of the original weight in residuals, which, however, would only represent a fifth part of the fuel required annually by the steam navigation of the world. On the other hand, the latter absorbs about a thirty-third of the annual output of 400,000,000 tons of coal of the world, or 12,000,000 tons.

(5) The enormous cost of liquid fuel is, however, the rock on which all attempts at introducing its use more widely in merchant vessels must founder. According to the present prices of coal and oil residuals, the latter, notwithstanding their higher power of evaporation, are about three times as dear as coal. The saving in stokers, the

cheapness of loading, and the other enumerated advantages do not materially alter their proportion. Only when new oil fields have been discovered and cheaper methods of transport have been introduced and oil residuals have been brought down in price to about double that of coal will it be at all possible for it to compete with coal in western Europe. Whether such a competition could last very long even then is very doubtful in view of the experience we have had in the rise of the price of oil in England when a steamer was to be propelled by it, and the contractors were compelled to return to coal. Of course the war navies, which are not so dependent on prices as the merchant marine, will reserve their verdict until they see, after the termination of the experiments still going on in England, Russia, and France, whether the much-vaunted tactical superiority of oil over coal is justified by the result. Should this be the case, as is probable, these nations and, perhaps, the United States, will possibly introduce liquid fuel on their torpedo-boats. Further, liquid fuel, if Laval's experiments prove to be practicable, will very probably be adopted for submarine vessels to an important extent; and finally, it is very possible, as indeed has been the case recently in North America, that liquid fuel will find adopters among the proprietors of pleasure yachts, for in all these cases economy is only a secondary consideration.

* * * * * * *

Russia and the United States, * * who are largely blessed with mineral oil, and England, which could easily procure a shale oil at a reasonable price from its own bituminous slate clay, have every reason to seriously consider the adoption of liquid fuel by their navies, especially now that its technical adaptability has been clearly demonstrated. If France should adopt liquid fuel, although it has but a few important oil-wells in the Sevennes, near Pezenas, and in the department of Hérault, the reason for this may be found in the fact that the coal-seams of France might, in the event of war, prove inadequate for the demands of her railways and fleet, as the mobilization of the seventeenth army corps is said to have proved. France would, therefore, be wise to provide an important section of her fleet, the torpedo-boats, with furnaces for liquid fuel. * * *

5. Conclusion.

In reviewing the preceding recorded opinions of experimenters and writers upon the subject of petroleum as fuel, we find—

1. That, mechanically speaking, all the difficulties in the burning of oil for the purpose of generating steam have been surmounted, and that it may safely be declared a success. The deposition of solid carbon and the consequent choking of the pipes has been avoided by not gassifying but atomizing the petroleum, in which state it is thoroughly mixed with air and completely burned. Any burner which avoids the distillation process before reaching the orifice accomplishes this. The use of steam for injection purposes is one of serious import. As previously stated the use of steam means the loss of an equal weight of fresh water, and fresh water is too valuable a commodity to be disposed of in this manner, especially when air can be made to do the same work. That air can do this work, and do it efficiently, was conclusively proved in 1883 at Marseilles with the Jensen sprinkler.

2. In economy petroleum can not compete with coal. Its cost is far in excess of that of coal, and even including the decreased cost of labor required, of repairs to boilers, etc., it is still in advance as regards expense. This, however, is a drawback to be considered only when seek-

ing commercial success; for torpedo-boats it is of but secondary importance, if of importance at all. If oil will increase the efficiency or the radius of action of our torpedo-boats, then oil must be used, no matter what it costs.

3. The safety in stowage and handling of petroleum has kept pace with the increase in use of the material. As its dangers became known, remedies were sought and found, and to-day there is no more danger with petroleum than with any other explosive when the same care and precautions are used. That discipline which obtains in the naval service insures the carrying out of all necessary precautions and results in as great safety from explosion in the use of petroleum as in the use of gunpowder, dynamite, or any other high explosive.

4. The advantages and disadvantages of oil fuel are clearly pointed out in the section devoted to them. The advantages which appear paramount are: The greater evaporative power of oil, which means more steam for the same weight of fuel, or, the weight of steam being constant, a smaller expenditure of fuel, and therefore a longer-lasting supply, or in other words, an increased radius of action for the boat; the complete combustion of the fuel which leaves no residues to be looked out for in the shape of ashes to be put overboard, tubes to be swept, and grates to be cleaned; the complete absence of smoke; the ease and speed of fueling at sea; the reduction in number and weight of firemen and their belongings, and the less fatigue of those retained.

All these are advantages of importance which are well worth the careful consideration of those interested in the development of our torpedo fleet, so happily inaugurated by the launching and successful performance of the *Cushing.*

XII.

THE MANŒUVRING DISTANCE OF STEAMERS.

By Lieut. F. F. **Fletcher**, U. S. N.

In General Information Series No. VIII was given the result of experiments showing the manœuvring powers of upwards of 50 merchant steamers. The information tabulated referred especially to the time required for each steamer to turn through certain arcs of the circle, and the time required to come to a dead stop from full speed by reversing the engines.

The more important information as to the distances in which these manœuvres were performed could not be ascertained, owing to the lack of facilities on board the steamers for making correct measurements. As the speed of a vessel and the time of performing any particular manœuvre can always be recorded with a fair degree of accuracy, it will be shown that with this data the distance traveled may be very closely approximated by a rule applicable to all vessels regardless of their tonnage and power of engines. The importance of knowledge of this character in regard to the manœuvring of steamers has been recently emphasized in a case of collision.

In trying the case of the collision of the *Normandie* it became necessary to ascertain what is the least distance she travels from the time of backing the engines at a full speed of 16 knots, until she comes to a dead stop. For this purpose a number of experiments were conducted by Lieutenant Chambers. It was found that it required 245 seconds to bring the steamer to a dead stop from a speed of 16 knots. The distance traveled in this time is not recorded as measured, and could only be obtained by calculation. Judge Addison Brown, of the United States district court of New York, before whom the case was tried, calculated this distance by the following approximate method.

It is assumed that the same force of the engine is exerted in backing full speed, as in going ahead full speed.

At full speed the retarding force exerted by the resistance of air and water is exactly equal to the power of the engine under the given conditions; otherwise the ship's speed would increase. If, then, the force of the engine under those conditions be represented by 16, on reversal at full speed of the engines the retarding force of the engine reversed will be represented by 16, and be uniform until the ship stops.

The other factors in the retarding force, viz, that of air and water, are not constant and uniform, but diminish with the diminishing velocity ahead. The resistance of the air to vessels varies from one-ninth to one-thirtieth that of water. The resistance of air is as the square of the velocity. The resistance of water is not exactly determined. Experiment, it is said, indicates the resistance to be as the square of the velocity up to about 10 or 11 knots' speed; between that and 15 or 16 knots, as the cube of the velocity, or sometimes exceeding that; above 16 knots' speed, returning to the square of the velocity, or even less. As the square of the velocity applies without doubt for the most part, and as that rule would produce a stop in the shortest distance, and the object is to find approximately the shortest theoretical distance, the computations are made under the latter rule.

If, then, the retarding force of air and water at the full speed ahead of 16 knots is represented by 16, the whole retarding forces when the engine is reversed at full speed will be represented at the initial moment of backing by 32.

When the speed has been reduced to 15 knots ahead, the retarding force of the engine will still be represented by 16; and the retarding force of air and water will be to the original force of 16 as the square of 15 is to the square of 16, viz, 14.06, so that the whole retarding force will then be represented by 30.06. In the following table the retarding force of air and water is given at each knot, until the vessel is stopped; this, added to the constant retarding force of the engine, gives the gross retarding force at each knot's speed until the vessel is stopped.

If the *mean* of the retarding forces between those of any two consecutive knots' speeds be taken, this mean will represent approximately the retarding force at work, while the speed ahead is reduced from the higher to the lower of those two knots.

While the ship is going ahead through the water, there is manifestly no force of air and water opposing the effect of the two retarding forces. In that respect it is like motion *in vacuo*. The rate of retardation is, therefore, directly proportional to the whole retarding force. Dividing up the whole period of slowing from 16 knots to zero into sixteen intervals of 1 knot each, the different times that the vessel will take to retard from any one knot to the next below will be inversely proportional to the retarding forces operating during the respective intervals, that is, approximately, in the inverse proportion of the *means* as above obtained.

If T be taken to represent the time that would be required by the engine alone to retard the speed of the ship one knot, 16 T would be the time for the engine alone to stop the ship from 16 knots. The time required to retard from 16 knots to 15 being inversely as the acting forces would then be $T \frac{16}{31.03}$ or T .5156. The following table gives the computation in time for each interval down to stopping in multiples of T. The aggregate, or 12.5746 T, being 245 seconds, T would equal 19.5 seconds very nearly, and the time of retarding from 16 knots to 15, viz, .5156 T, would be 10 seconds, and as the mean rate of motion between 15 knots and 16 knots is 15.5 knots, or 26.177 feet per second, the distance traversed in retarding from 16 to 15 knots would be about 262 feet.

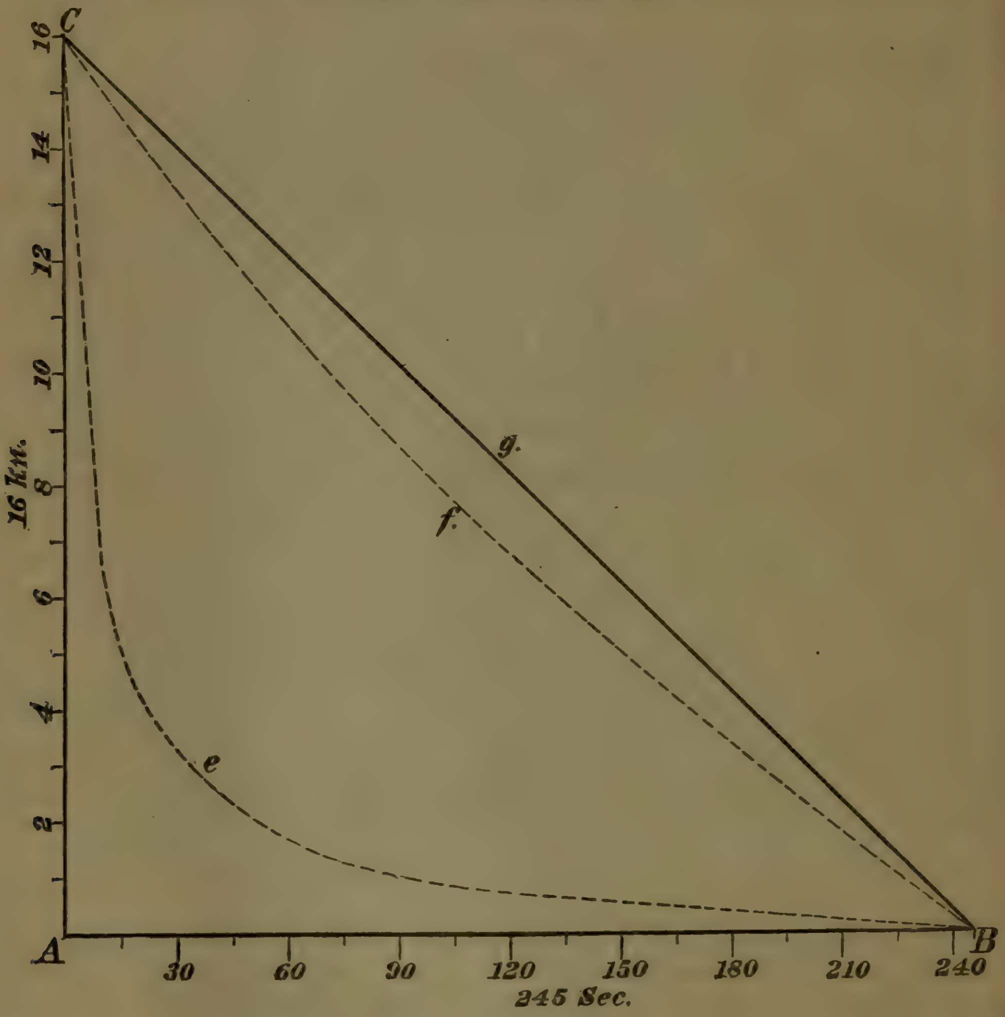
The following table gives the time and distance for each interval computed as above, on the basis of stopping from 16 knots in 245 seconds, making the distance traversed about 2,916 feet, or about 6 lengths of the ship.

Speed ahead	Resist power.	Total power.	Mean power.	Retarding from.		Time.	Distance.
							Feet.
16	16	32	31.03	16 k. to	15	$T \frac{16}{31.03} = T .5156 = 10s$	262
15	14.06	30.06	29.15	15	14	$T \frac{16}{29.15} = T .5489 = 10.7s$	261
14	12.25	28.25	27.40	14	13	$T \frac{16}{27.4} = T .5917 = 11.5s$	260
13	10.56	26.56	25.78	13	12	$T \frac{16}{26.78} = T .6206 = 12.1s$	255
12	9	25	24.23	12	11	$T \frac{16}{24.23} = T .6603 = 12.87s$	246
11	7.56	23.56	22.90	11	10	$T \frac{16}{22.90} = T .6987 = 13.62s$	241
10	6.25	22.25	21.66	10	9	$T \frac{16}{21.66} = T .7386 = 14.40s$	231
9	5.06	21.06	21.47	9	8	$T \frac{16}{20.47} = T .7817 = 15.25s$	222
8	4	20	19.53	8	7	$T \frac{16}{19.53} = T .8193 = 15.97s$	201
7	3.06	19.06	18.66	7	6	$T \frac{16}{18.66} = T .8521 = 16.62s$	180
6	2.25	18.25	17.96	6	5	$T \frac{16}{17.96} = T .8908 = 17.35s$	161
5	1.56	17.56	17.28	5	4	$T \frac{16}{17.28} = T .9258 = 18.05s$	156
4	1	17	16.78	4	3	$T \frac{16}{16.78} = T .9556 = 18.63s$	110
3	.56	16.56	16.41	3	2	$T \frac{16}{16.41} = T .9750 = 19.01s$	81
2	.26	16.25	16.14	2	1	$T \frac{16}{16.14} = T .9913 = 19.33s$	48
1	.06	16.06	16.03	1	0	$T \frac{16}{16.03} = T .9990 = 19.48s$	17
				Total....		T 12.5649 = 245*s*	2,916

If the backing efficiency of the screw were toequal its propelling efficiency, and the resistance of the water were to vary as the square of the velocity, a steamer would be brought to a dead stop in a shorter distance than what is now found to be the case by actual trial. Since both these assumptions were used in the above calculations of Judge

Brown, it might therefore appear that the *Normandie* could not have traveled a less distance than 2,916 feet in the 245 seconds while coming to rest. But a further investigation will show that 2,916 feet, instead of being the least distance, is in reality the greatest distance she could have traveled in that time.

This conclusion is based upon the following considerations. If a body in motion is acted upon by a constant retarding force, its velocity is destroyed in direct proportion to the time during which the force acts, and its mean velocity during this time is equal to one-half the sum of its original and final velocities. In the case of the *Normandie*, let us disregard the retarding force of the water, and consider only the retarding force of the propeller. The retarding force being assumed as constant, the time required to destroy each knot of speed will be one-sixteenth of 245 seconds, or 19½ seconds. The average speed would be 8 knots, and she would travel in the 245 seconds a distance of 3,310 feet whatever may have been the power the engine exerted to bring the ship to rest in this time. The retarding force being constant, the mean speed can not exceed one-half the original speed.



In the diagram, let A C represent the speed, 16 knots, and A B the time, 245 seconds. Marking opposite each knot the time required to make the reduction to that speed, we obtain the line C g B, which represents the speed-curve of the ship under the above conditions.

Let us now disregard the retarding force of the engines, and consider only the retarding force of the water. The time required to reduce each knot of speed will be inversely as the retarding force, and this force is as the square of the velocity at which the reduction is made.

The resistance of the water is a decreasing retarding force and reduction of speed therefore takes place rapidly at high velocities and slowly at low velocities, and the average speed will approach more nearly the low speeds which the ship maintains for the longest intervals of time.

If it be assumed that the retarding force of the water alone brings the *Normandie* to rest in 245 seconds, and we mark opposite each knot the time required to reduce to that speed, the curve C e B on the diagram will be obtained, representing the speed-curve of the *Normandie* under the above conditions.

When both the retarding force of the water and the backing force of the engines are acting together, the result is a decreasing retarding force. The greater the resisting power of the propeller the more nearly constant is the retarding force and the speed-curve approaches the line C g B: the less the retarding power of the engines the greater is the decrease of retardation and the speed-curve approaches the line C e B. That is, the greater the backing efficiency of the propeller, the higher is the average speed, and the less the backing efficiency the lower is the average speed of a ship while being brought to a stop.

This holds good for all vessels, practically independent of tonnage, engine power, or form of hull.

In the diagram C f B represents the speed-curve of the *Normandie* as plotted from the calculation of Judge Brown, assuming that the backing efficiency of the propeller was equal to its full propelling power. Had the backing efficiency of the propeller been less than that assumed, the speed-curve would fall below C f B and the ship would have had a lower average speed and traveled a less distance than 2,916 feet in the 245 seconds. Had it been greater than the full propelling power, the speed-curve C f B would have approached C g B, the ship would have had a higher average speed and traveled a greater distance than 2,916 feet in the 245 seconds.

The actual distance run may be determined by ascertaining to what extent the average speed is influenced by the backing efficiency of the propeller.

Mr. J. H. Heck (Institution of Naval Architects, 1888) obtains the following formula for the distance and time required to bring a ship to rest:

Let D=displacement.
V=speed.
L=distance.

r=resistance at velocity 1.
g=accelerating force of gravity.
R=retarding force of propeller. E=2.71828.
T=time from speed V to o.

Then—

(1)
$$L=\frac{D}{g\,r\log E}\log\left(1+\frac{r\,V^2}{R}\right)^{\frac{1}{2}}$$

(2)
$$T=\frac{D}{\sqrt{r}\,g\,\sqrt{R}}\tan^{-1}\left(\frac{\sqrt{r}\,V}{\sqrt{R}}\right)$$

With the distance and time thus determined, Ensign P. R. Alger, U. S. Navy, obtains an expression for the value of the average speed as follows:

Let m=ratio of backing force of the propeller to its propelling force.
c V=average speed of ship while coming to rest from speed V.

The distance traveled while coming to rest is equal to the average speed multiplied by the time, or—

(3)
$$L=cVT$$
$$cV=\frac{L}{T}$$

Substituting the value of L and T—

(4)
$$cV=\frac{\sqrt{R}\log\left(1+\frac{rV^2}{R}\right)^{\frac{1}{2}}}{\sqrt{r}\log E\tan^{-1}\left(\frac{\sqrt{r}V}{\sqrt{R}}\right)}$$

Since the full retarding efficiency of the propeller while backing is equal to the propelling efficiency at speed V equals rV^2, $R=mrV^2$, or,—

(5)
$$m=\frac{R}{rV^2}$$

Substituting in (4)

(6)
$$c=\frac{1}{2}\sqrt{m}\,\frac{\log\left(1+\frac{1}{m}\right)}{\log E\tan^{-1}\sqrt{\frac{1}{m}}}$$

There is thus obtained, in terms of the backing efficiency of the propeller, a value for the average speed of a ship while coming to rest. By assigning different values to the backing efficiency of the propeller, the corresponding values of c, multiplied by the original speed, will give the average speed. In the case of the *Normandie*, let it be assumed that with each value of m, the ship will be brought to rest in 245 seconds, then the distances run would be as follows:

Backing efficiency of propeller.	Average speed.	Distance in 245 seconds.
		Feet.
$m=1.$	$c=.4413\ V$	2921.6
$m=.8$	$c=.4311\ V$	2854
$m=.6$	$c=.4160\ V$	2748
$m=.4$	$c=.3936\ V$	2606

Although the power with which the engines are backing greatly affects the *time* and *distance* in which a ship is brought to rest, it is seen from the above, that it does not greatly affect the *average speed* during that time.

The backing efficiency of propellers lies between the limits of eight-tenths and four-tenths of the propelling efficiency, and if a value of six-tenths be taken in calculating the distance a ship will travel before coming to rest, the result will not be in error more than 5 per cent. We have thus obtained the following practical rule.

The distance any ship travels from the time her engines are reversed until she comes to rest, is forty-two one-hundredths of the distance she travels in the same time at her original speed.

If a ship backs with an engine power greater than that due to her original speed, the percentage, forty-two one-hundredths, will be modified in accordance with the value of m, assumed in (6).

To test the accuracy of this rule by practical example:

The U. S. S. *Atlanta*, at full speed of 12 knots, reversed the engines and came to a dead stop in 1 minute, 48½ seconds, in 884 feet.

12 knots for 1 minute 48½ seconds	feet	2201.6
2201.6 by .42	do	924.7
By experiment	do	884.0
Difference	do	40.7
Error	per cent	4½

A torpedo-boat, at a speed of 20 knots, reversed and stopped in 30 seconds in 448 feet.

30 seconds at 20 knots	feet	1014.0
1014 by .42	do	425.9
By experiment	do	438.0
Difference	do	12.1
Error	per cent	$2\frac{7}{10}$

Assuming the formula to be correct the backing efficiency of the *Atlanta's* propeller in the experiment was five-tenths and that of the torpedo-boat was a little over six-tenths the full propelling efficiency at the given speed.

Applying the rule to the list of vessels tabulated in General Information Series No. VIII, an idea may be obtained of the distance in which the average ocean steamer has the power to manœuvre.

Name of vessel.	Gross tonnage.	Length.	Beam.	Speed.	To stop.		Distance.
	Tons.	*Feet.*	*Feet.*	*Knots.*	*m.*	*s.*	*Feet.*
Sir Garnet Wolseley	2, 239	292	37	10. 00	3	00	1, 260
Exeter City	2, 198	285	38	10. 00	4	00	1, 680
Dalton	2, 039	315	35	10. 00	2	00	840
Dalton (loaded)	....	....	....	10. 00	4	00	1, 680
Manhattan	1, 525	228	35	11. 50	2	45	1, 328
Gutheil	....	....	....	9. 50	1	42	678
Willamette	2, 561	335	39	10. 00	2	00	840
Westernland	5, 736	440	47	14. 50	1	30	913
Yorkshire	2, 192	330	35	9. 00	7	00	2, 646
Yorkshire (light)	....	....	....	9. 00	2	00	756
Pennsylvania	3, 104	343	43	12. 00	2	20	1, 176
Seneca	2, 729	271	42	14. 00	1	30	882
Ethiopia	4, 005	402	40	12. 5	3	05	1, 618
Guyandotte	2, 351	267	40	13. 00	3	00	1, 638
City of Richmond	4, 780	440	44	14. 50	2	45	1, 508
Wyoming	3, 238	366	43	14. 00	2	40	1, 448
Westmoreland	1, 384	240	32	14. 5	3	00	1, 627
Villaverde	3, 460	....	....	12. 00	6	00	3, 024
La Champagne	6, 800	493	52	17. 5	5	00	3, 675
Minneola	2, 404	284	37	10. 5	4	45	2, 109
Richmond Hill	4, 126	430	27	12. 5	2	45	1, 435

The results in the table are approximate, as in most cases the speeds and times recorded do not show evidence of having been accurately ascertained. The practical rule given above will enable a commander to determine the manœuvring distance of his steamer until a favorable opportunity occurs to verify it. The distance is most readily calculated as follows:

Let S = speed in knots and tenths.

t = time in seconds.

Then

$$\text{Distance in feet} = \frac{7}{10} S\, t.$$

XIII.

AUTOMOBILE TORPEDOES, THE WHITEHEAD AND HOWELL WITH A DETAILED DESCRIPTION OF EACH.

By Ensign John M. Ellicott, U. S. Navy.

The invention of the Whitehead automobile fish torpedo pointed out a new channel for human thought and ingenuity to follow in searching for destructive weapons of naval warfare. No patent rights existed to leter other people from imitating the weapon if they could, but at the same time its mechanism remaining a secret prevented any improvement being made upon it except by the inventor himself. Thus for years the imitations were confined to their experimental stages in striv-ng to overcome initial difficulties, while the Whitehead itself was, no loubt, somewhat retarded in its development. It was not until an imi-ation came into existence possessing a distinct and vital power which he Whitehead lacked that torpedoists began to expect a rival weapon. This latter, the Howell torpedo, passed quickly through the experi-nental stages, has been much improved, and is now an adopted and regu-arly manufactured automobile fish torpedo both in the United States nd Europe. It is, therefore, the first, and only one as yet, to reach a osition of established rivalry with the Whitehead. Its mechanism is overed by patents, and therefore open to public examination. The nechanism of comparatively recent Whiteheads has also, in the last year or two, become public property through French publications. Hence a detailed description of each can be given here for the benefit of the service.

The Whitehead torpedo (Plate I) consists of a cigar-shaped envelope of steel or phosphor-bronze containing six compartments for its pro-pelling, directing, and exploding mechanism. Its motive power is com-pressed air; it is propelled by two 2-bladed screws revolving in op-posite directions about the same axis in order to neutralize their indi-vidual tendencies to produce lateral deviation; and it is maintained at a constant depth by horizontal rudders and on a straight course by vertical vanes set at an angle predetermined by experiment. The older models should maintain the prescribed depth and straight course for a distance of from 400 to 500 yards at a speed of from 20 to 24 knots. The latest models, more fish-like in shape, fuller forward and with a finer run, have attained a speed of 30 knots for 425 yards and 24 knots for 875 yards.

For description the torpedo may be conveniently divided up as follows: (1) the magazine; (2) the secret chamber; (3) the reservoir; (4) the machinery chamber; (5) the buoyancy chamber; (6) the bevel-gear chamber; (7) the tail.

THE MAGAZINE.

The forward compartment or magazine contains the explosive cartridge and the firing arrangement (Plate II).

The cartridge, Fig. 1, consists of a series of disks, I, II, III, IV, etc., of wet gun-cotton, of equal thickness, contained in a metallic case shaped to fit the chamber. The number of disks varies in different models, and a sufficient number of them, counting from forward, are pierced through their centers to receive the cartridge primer P. These discs are held firmly in their case by an annular ring of felt, *f*, at its after end. The cartridge case itself is held firmly in place by a buffer, *b*, of felt, fitted in a circular socket attached to the after bulkhead of the magazine.

The cartridge primer P, which is inserted in a tube passing through the perforated disks, consists of a series of small cylinders of dry gun-cotton, *c c c*, contained in a metal case which is closed at its rear end by a disk of rubber, *r*, and at its forward end by a countersunk brass cap, *s*, to which it is soldered. The forward cylinder of gun-cotton is pierced through its center to receive a small copper tube, *t*, which is flanged into the brass cap *s* and closed at its inner end. This tube receives the detonating primer.

The detonating primer, Fig. 2, consists of a brass case, *a*, containing compressed fulminate of mercury, which is protected from moisture by a layer of vermilion gumlac. Into this case is fitted a cup, *u*, containing a percussion cap, *i*, and an anvil, *v*. The cup is pierced at *o*, and the anvil is guttered to allow the passage of flame. The whole is covered by a cap, *h*, to protect it from accidental shocks.

The firing arrangement, Fig. 3, is made up as follows: A small *right*-handed screw propeller, L, of four blades is retained in a sleeve, S, by means of a lug-screw, *w*, projecting in between two collars, *l l*, on the shaft. The remainder of the shaft in rear of the collars is square in section, and on it travels an inner sleeve, S′, screwing into S with a *left*-handed screw. The outer sleeve, S, fits into a cylindrical aperture in the stock T, but is prevented from rotating and limited in travel by the stud screw *d* fitting in the slot *x*. In rear of this sleeve is the firing-pin *v*, held in place by a lead safety-pin, *z*, passing through it and the stock. The stock T has two shoulders on which are screw-threads of opposite pitch. The inner one screws into the brass cap in the head of the cartridge primer, and the outer into a bouching fitted to the magazine envelope (see Fig. 1). Thus, when the firing arrangement is unscrewed from the torpedo, the cartridge primer is withdrawn with it, and the torpedo rendered inoffensive.

Before fitting the firing arrangement the inner sleeve S′ is screwed back into the outer sleeve S until the lug *k* brings up against the spur *m* (this contact preventing the sleeve from jamming against the collar *l*). The action then is as follows: As the torpedo passes through the water the propeller L revolves, causing the inner sleeve S′ to travel back along the square spindle until its base brings up in a socket, *o*, in the head of the firing-pin *y*. The travel of S′, thus arrested, is taken up by the outer sleeve S, which now travels forward, withdrawing the square spindle from the inner sleeve. For a short distance from its forward end the hole through the inner sleeve is circular (see Fig. 4). When, therefore, the square spindle recedes to this point rotation ceases to be transmitted to the inner sleeve, and the further revolutions of the propeller are of no effect. Contact with the target will now drive back the outer sleeve S upon the stock T, and, through the medium of the inner sleeve S′, break the lead-pin *z*, and drive the firing-pin upon the detonating primer.

This firing arrangement was first perfected in the Model 1886 torpedo, but has since replaced the old percussion point in all models.

THE SECRET CHAMBER.

This chamber contains the immersion regulators. It is just forward of the reservoir, as indicated in Plate I, Fig. 1, and the transmitting rods pass through a tube in the latter, which is secured with an air-tight joint in each bonnet.

The purpose of the mechanism in this chamber is to control the horizontal rudders after launching so as to bring the torpedo to a predetermined immersion and keep it there during its flight. This is accomplished as follows:

The small compartment in front of the secret chamber (Plate III, Fig. 1), has free communication with the water outside through several apertures in its walls. The pressure of water due to depth below the surface acts against a piston, *a*, but the water is prevented from getting behind the piston by an annular diaphragm, *c*, of thin rubber. The motions of this piston, due to different pressures of varying depth, are communicated to the horizontal rudders by means of the rod *r* (fixed to the piston), the link *y* (pivoted at *z*), and the rods r' and r^2 in such a manner that when the torpedo is below its plane of immersion the increased pressure will elevate the rudders, and when it is above the decreased pressure will depress them.

When the torpedo is in its plane of immersion the piston is kept in mid position by an equilibrium between the pressure of the water and the tension of three steel springs, R R, 120° apart, setting up against it through the cross-head B and the rod C (screwed into the piston-stem T). To set the springs to the desired tension, the cap *n* (on the piston-head) is removed, and a wrench inserted into the square socket *m* in the piston-stem. Turning the wrench will screw the stem T up or down on the rod C, and increase or decrease the tension of the springs upon it as desired. The square head of the wrench has graduations marked upon its faces which, coming flush with the face of the piston-head, indicate the tension of the springs.

Were the pressure of the water the only controlling force upon the horizontal rudders the oscillations of the torpedo above and below its plane of immersion would be excessive and perhaps continuous; for it is not alone necessary to throw a vessel's helm over when she is off her course, but to ease the helm as she approaches the course. To this end the motion communicated to the rods r' r^2 by the piston P is modified by pivoting the link *y* at *z* to the arm M of a pendulum, W. The pendulum is free to swing about pivots, *t*, on the ends of the bracket L, fixed to the envelope.

The resultant action is as follows: suppose the torpedo, after its initial plunge, to be below its plane of immersion and pointed downward. The pendulum W has swung forward. For the moment the link *y* has pivoted about *u*, the pendulum force being applied at *z*. The rods r' r^2 are thus forced aft and elevate the rudders. Almost immediately, too, the pressure of water upon the piston *a* moves *it* aft, and with it the rod *r*. The link *y* now pivots about *z*, and the rods r' r^2 are forced still further aft. The rudders are thus "hard up," and the effort upon the torpedo is to turn its point upward. As this is accomplished the pendulum swings gradually aft, reducing the rudder angle until, as the torpedo begins to point upward towards its plane, the action of the piston has been neutralized and the rudders are straight.

Now the torpedo rises, and, the pressure upon the piston decreasing, the influence of the pendulum predominates. The latter being aft and the link *y* pivoting for the time about *u*, the rods r' r^2 are drawn forward and the rudders slightly depressed. The tendency is now to steer the torpedo into its plane of immersion instead of allowing it to pass above. This can not be accomplished at once, however, and the torpedo passes above its plane of immersion and pointed upward.

The pressure of water upon the piston is now less than the tension of the springs R R, and they push the piston forward. With it the rod *r* is drawn forward, carrying the link *y* pivoting about *z*. The rods r' r^2 are thus still further drawn forward and the rudders are "hard down," exerting their maximum effort to turn the torpedo point downward. As this is brought about the rudder angle will be gradually diminished by the pendulum swinging forward, until it becomes zero as the torpedo begins to point downward and re-approach its plane.

As the torpedo now goes downward the pressure of the springs against the piston is gradually neutralized by the increasing pressure of water against them, and the influence of the pendulum is thus again allowed to predominate. The latter being forward, the rudders are slowly raised and tend to bring the torpedo into its plane of immersion without passing below it.

Thus it will be seen that by the controlling influence of this mechanism the vertical trajectory of the torpedo will be a wave line passing alternately above and below the plane of immersion, with a continually decreasing amplitude until it becomes practically straight and lies in that plane. As a matter of fact, discovered from actual curves, only the first three or four oscillations are at all large when the mechanism is well adjusted. After that the trajectory is straight as long as the speed of the torpedo is constant. As the speed decreases with falling pressure the torpedo rises toward the surface.

In the drawing *s s* are springs of light tension which take up shocks or irregular motions of the pendulum. The rock-shaft I, between r' and r^2, is necessary only to make their connection through the bulk-head water-tight.

The impulses of the mechanism in the secret chamber are insufficient to move unaided the numerous cranks and rods connecting it with the horizontal rudders. A device called a *servo motor* is therefore interposed, so that the impulses of the regulators are transmitted only to a valve in the machinery chamber, and by the motion of this valve augmented impulses are transmitted to the rudder rods beyond by means of compressed air from the reservoir.

The *servo motor*, Fig. 3, consists of a bronze barrel, C, bolted to the after bulk-head of the machinery chamber by two standards, *f*, and containing a hollow piston, P, within which works the valve T. Beneath the barrel is a nipple, E, communicating with the compressed air. The piston P has three annular grooves, *x x x*. The two extreme ones are packed with hemp packing, oiled and tallowed, and the middle one is of such length that when the piston is in its extreme positions the groove is still in communication with the air-pipe E. From this middle groove two channels, *z z*, run diagonally, as shown, to the central aperture of the piston. On either side of the zone where these channels debouch is another channel; the one forward, *c*, passing to the after end, and the one aft, c', passing to the forward end of the piston; both channels changing direction at right angles in the body of the piston in order to reach their respective ends. The valve T is of square cross-section, except at b' and b'', where it is circular and fits closely the central aperture of the piston P. The valve stem *b* passes freely through a screw cap, *e*, in the head of the piston, but is limited in its travel by two collars, as shown.

The impulse of the immersion regulators in the secret chamber is transmitted by the rod r^2, Fig. 1 (through the bell-crank shown in Fig. 4, Plate VI, the vertical rod I, and the bell-crank A, Plate III), to the valve-stem *b* and valve T. Suppose this impulse to push the valve aft (to the right). The cylindrical part b'' clears the channel c', and the compressed air, flowing through E, x, and z z', passes the square part of the valve between b' and b'' and flows out through the channel c' to exert its pressure upon the forward (left hand) side of the piston P and move it aft. Any air on the after (right hand) side of the piston can exhaust through its channel c, and, since b' has moved to the right, past the square part of the valve and around its stem, b, into the machinery chamber.

If the valve T were moved forward (to the left) by the regulators the channel c would communicate with the compressed air and c' would exhaust through the central aperture of the piston P and the channel n in the stem B, and P would move forward.

Thus any movement of the valve T results in a movement of the piston P in the same direction, and with greatly increased power.

Both stems of the piston are packed air tight in stuffing-boxes, as shown, and the after stem B is screwed to the rudder rod r^3. This rod passes through the buoyancy chamber and connects with the horizontal rudders (H, Plate VI, Fig. 1) through the connecting rod r^4, the bell crank b'', the connecting rod r^5, the lever l, the connecting rod r^6, and the lug u on the rudders; the axis of the rudders being at x''.

THE RESERVOIR.

The reservoir for compressed air (Plate I, Fig. 2) is made of cast-steel and forged on a mandril. The ends are dome-shaped bonnets, B B, with outer flanges, f f, to fit into the other sections of the torpedo. To insure air-tight joints both the shell and bonnets are heated before screwing together, the shell having the greater heat. The screw threads are at the same time carefully tinned. As a further precaution, the bonnets are secured by a number of small radial screws, s s. On the after bonnet is a *tuyere*, t, by means of which communication is made between the air reservoir and the main engine. The reservoir is secured to the other compartments by means of two lugs, l l, (diametrically opposite), with bolts and nuts, and by numerous radial screws through the flanges.

The reservoir is tested for strength up to 105 atmospheres with oil pressure. Flaxseed oil containing litharge is used. It penetrates the distended pores of the metal, and when the reservoir is drained after test an excellent air-tight coating is left upon the inner walls. Then the test for air-tightness is made up to 70 atmospheres, the condition being that the pressure shall not fall 6 atmospheres in four hours.

In the last few years improvement in the quality of metal has made it possible to charge the reservoir to a much higher pressure.

THE MACHINERY CHAMBER.

Next abaft the reservoir comes the rear cone (Plate I, Fig. 3) containing two compartments, the machinery chamber and the buoyancy chamber. Between them is a bulkhead, K, bolted to a flange, *g*. The flange is riveted and soldered to the envelope and the joint between it and the bulkhead is made water-tight by a rubber gasket. To this bulkhead the propelling machinery is secured. This consists of a Brotherhood or Whitehead engine, a starting valve, and a pressure governor. Previous to 1880 the motor used was the Brotherhood engine, but in the models of that year and later ones the motor is a modification of the Brotherhood known as the Whitehead engine (Plate IV, Figs. 1 and 2).*

The Whitehead engine consists of three cylinders, A A A (Fig. 2), fixed radially about the propeller shaft, with their axes 120° apart. Within the circular inclosure at the junction of the cylinders the main crank is free to revolve and receives its impulse from the piston of each cylinder in succession. The compressed air is admitted behind the pistons and evacuated in proper order by means of three slide valves, each working in a separate chest, S, on the forward face of each cylinder, but all regulated by a single cam, Q, keyed to the main shaft.

The valves consist of a cylindrical disk, T, of bronze, cast in one piece with a stock, *t*, carrying four guide blades, *l l l*, and it slides in a bronze sleeve, C, perforated with radial ports, *o o*, which open upon an annular aperature, E, in the valve chest, communicating with the cylinder space behind the pistons. The valve stem is in two parts, screwing one into the other to allow adjustment. One part simply sockets in the valve stock, as shown in the drawing, while the other is split and carries a small roller, X, in contact with the cam Q. The compressed air is admitted into the space *u*, behind the valve disk T, and maintains the contact between the valve, the stem, and the cam in all positions. By removing the screw caps *v* from outside the torpedo the valves may be readily removed and overhauled, or the valve stems set.

In Fig. 1 the position shown is when the piston is about to commence its return stroke and the air is exhausting from behind it, as shown by the arrows. When the piston has completed its return stroke the cam Q will have rotated until the valve T, moving toward the main shaft, opens communication through the ports *o* with the annular aperture E, and admits the compressed air into the cylinder behind the piston. The cam Q regulates the valve motion to cut off at about half stroke. In the Model 1885 torpedo and later ones it is about four-tenths stroke. Thus as the air is acting at full pressure in one cylinder it is acting expansively in the next and exhausting from the third.

When the torpedo is launched from a submerged frame or skeleton tube the working of the pistons and valves is much impeded by the water which backs up into the cylinders through the exhaust pipe. A little reservoir, D, is therefore provided for each cylinder. The water, when backed up through the channel *e*, lifts the metal ball *d*, and, entering the reservoir D, is retained there by the ball falling back again over the orifice.

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* Brotherhood improves his engines continually, and they are very probably still used in torpedoes not manufactured at Fiume. Schwartzkopf also uses a patented type of three-cylinder engine.

To remedy the evil in the latest models the slide-valves T are made in two parts as shown in Fig. 3. When there is water in the cylinders it can escape upon compression through the holes *u*, separate T′ and T″ as shown in the second view, and pass off as indicated by the arrows. At other times T′ and T″ are kept together, as shown in view 1, by the air pressure behind T′. The slide-valve is thus also a cylinder relief valve.

The piston-rods are fitted in the pistons with a ball and socket joint, as shown in both Figs. 1 and 2, and attached to the crank by means of blocks, K, with feathers at each end fitting in annular grooves, *q q*, cut into the inner faces of the crank-webs. The crank has a counterbalance, *g*, forged in one piece with it. The crank and propeller shaft are of steel, the latter being hollow. The air exhausting through it acts as an additional propelling force. The piston-rods are also of steel and the pistons, cylinders, and blocks K of bronze or brass.

The compressed air is turned on the machine by opening a valve (T, Plate V, Fig. 3) which will be described further on, but before reaching the cylinders, it passes through a pressure governor (Plate V, Figs. 1 and 2). The air-pipe T′ passes from the starting valve T to the governor through the machinery bulkhead, and serves to secure the governor to the bulkhead as shown. The governor consists of a hollow cylindrical slide-valve P, of bronze, closed at its upper end but perforated radially with three rows of square ports *e*, 1.4 inches across, opening upon three annular air ports *e′*, 1 inch across, which communicate with the air-pipe T′ (Fig. 2) through the channel *a*. At rest the valve ports should be squarely over the air ports, lapping them two tenths inch on either side. This can be adjusted by leather washers, *w*, under the cap *o* (Fig. 1), upon which the foot of the valve rests. Above the valve is a spindle, *t*, seated upon the barrel by a shoulder, *s*, so that its foot, although inserted in a socket in the valve as shown, is not in contact with it by two tenths of an inch when the valve is at rest. The spindle is kept thus by a spring, *r*, set to the desired working pressure by a set-screw, *j*, screwing into the casing K. The starting valve being opened the compressed air passes through T′ and *a* (Fig. 2) and through the ports *e e′* into the valve. The latter at once rises into contact with the spindle above it, bringing the lower faces of both air and valve ports flush. The air flows out through openings under the foot of the valve into an air chamber, R, as shown by the arrow in Fig. 2, and from this chamber to the slide valves of the main engine. The spring *r* is set to a tension of about 24 atmospheres. This being much lower than the pressure in the reservoir the valve rises against the spring and thus partially closes the air ports until an equilibrium of pressures is established. The air pressure at the engine thus remains constant until the pressure in the reservoir is the same. The spring *r* then seats the valve P, and the ports are opened full, allowing the engine to run under the continually diminishing pressure in the reservoir until the air is exhausted.

The air chamber R, has one and one half times the volume of one cylinder of the main engine and serves to store up air as a cushion to reduce irregular and violent motions of the valve P. This provision has proven superfluous since the introduction of the Whitehead engine, and in the Model 1886 torpedo the chamber R ceases to exist.

To prevent the escape of air between the sliding faces of the valve P and the barrel C two annular grooves are cut in the barrel above and below the air ports. These communicate through channels, as shown in Fig. 1, with a reservoir of oil, *m*. The surface of this oil is in communication with the air in the reservoir through a tube, *d*, and a pass-over pipe, *f*, and the oil is thus pressed down through the channels *g* into the annular grooves *n n* around the valve P, forming thus an oil packing. The reservoir *m* is charged with oil from outside of the torpedo envelope by removing the screw plug V.

When the air chamber R was omitted the oil reservoir *m* was shifted abaft the machinery bulkhead into the buoyancy chamber, its connections leading through the bulkhead as does the air pipe T′.

The starting valve is shown in Fig. 3. It connects through the machinery bulkhead with the air pipe T′, and is set up to the bulkhead by a nut, E (see also Fig. 2). It is connected at its forward end with the charging valve, which is secured by a flange, D, to the envelope of the torpedo. Still further forward the pipe *a* is secured by a flange to the *tuyere* on the after bonnet of the reservoir (see *t*, Plate I, Fig. 2). The valve *d* is kept seated by the spring *r*, under a compression of 2 atmospheres, and also, when the reservoir is charged, by the air pressure in the latter. When the lever L is thrown back, as shown by dotted lines, about the axis *o*, a cam, C, acting against the valve stem *g*, opens the valve and allows the compressed air to flow from the reservoir to the governor, and thence to the main engine. The spring *g*, under compression, will retain the lever L in either open or shut position. The lever is thrown back, or open, by coming in contact with a lug in the launching tube when the torpedo is launched. In above water discharge this scheme is defective, causing violent rotation of the propellers before the torpedo is submerged, and resulting in severe strains upon the machinery and useless consumption of compressed air. In the Model 1885 torpedo a new and delicately balanced starting valve was introduced, having on its lever a cross-vane which would be thrown back by the resistance of the water when the torpedo made its plunge. The idea came from the Russians, who applied it first in 1881. The action of this valve proved unreliable, so it was almost immediately abandoned, and, although the effort to perfect it is unceasing, the valve shown in Plate V, Fig. 3, is the one still in use.

To charge the reservoir, the screw plug *b*, Fig. 3, is removed from outside, and a nozzle screwed in having a pintle which presses the valve *c* back from its seat. The spring *r′* is under a compression of 2 atmospheres.

THE BUOYANCY CHAMBER.

This compartment is an air-tight shell (Plate I, Fig. 3), braced with annular rings, *g*. Passing through it are two tubes, H and *h*. H contains the connecting rods to the horizontal rudders and *h* the connections for suspending the action of these rudders until the torpedo is submerged, and also those for stopping the torpedo after a certain length of run. The central tube *d* contains the main shaft.

The purpose of the buoyancy chamber is to give a certain preponderance of buoyancy to the torpedo during flight, to ensure its returning to the surface after an experimental run, or, by flooding the chamber, to cause the torpedo to sink if it misses its target or fails to explode upon impact in actual warfare. The air tightness of the chamber can be verified by submersion, and, should it not be perfect, any water which gets in can be drained off through a small hole under the chamber by removing a screw plug, *p*.

There is also in this chamber a piece of lead ballast, *m*, of such size and so placed as to counterbalance any tendency of the interior fittings of the torpedo to alter its trim, either horizontally or about its axis.

The volume of the buoyancy chamber is 10 gallons for the Model 1880 torpedo.

THE BEVEL GEAR CHAMBER.

Next abaft the rear cone, and secured to it as shown in Plate VI, Fig. 1, is the bevel gear chamber. The object of the gearing in this chamber is to cause the propellers to revolve in opposite directions. The after propeller is keyed on the main shaft A. To this shaft is secured the bevel gear wheel *b*. The forward propeller is keyed to a sleeve, A′, free to rotate about the main shaft A. To the forward end of this sleeve is secured the bevel gear wheel *b′*. Rotation in opposite directions is transmitted from *b* to *b′* by means of two bevel gear wheels, *g g′*, free to turn upon a spindle, *a*, at right angles to the main shaft, screwed into the walls of the chamber and enlarged at its center to allow a hole through it for the shaft A. The rods passing through the buoyancy chamber also pass through the bevel gear chamber. The propellers, besides being keyed, are secured to their respective shafts by washers, *w w′*, screwed over them.

THE TAIL.

The tail of the torpedo consists of two parts, the rudder support and the rudders. The former consists of a conical stock, K, screwed on the bevel gear chamber, which carries four fins, two vertical, F F, and two horizontal (not shown). These fins are either cast in one piece with the stock or riveted to flanges upon it. From the vertical fins shoes, S S′, extend aft. and to these the vertical vanes V V are secured. The upper shoe has a lug, *u′*, which fits in a longitudinal groove in the top of the launching tube and keeps the torpedo upright in launching. The lower shoe opens to form a frame, *f f*, in which is pivoted the lever *l* of the horizontal rudders.

The after part of the tail consists of a stock, K′, with vertical vanes, V V, which act as the vertical rudder, and with two horizontal rectangular frames, R R, in which are set the horizontal rudders H. To the outer extremities of these frames rods are attached which extend forward and fit in sockets on the outer edges of the horizontal fins of the forward part. By properly adjusting the set screws which secure the rods in their sockets sufficient inclination can be given to the vertical vanes V V to counteract any tendency of the torpedo to lateral deviation. Experiments are always made to determine this correction.

There is an unnatural strain brought upon the shoes S S′ by this method of inclining the vertical vanes, and sometimes, too, the free action of the horizontal rudder rods is impeded. A new arrangement introduced by Schwartzkopf has therefore been adopted since 1880, and is shown in Plate VII, Fig. 4. On the horizontal fins of the tail stock little vertical rudders, *a a*, above and below the fins in the same vertical plane, are pivoted at *b b*, and are set to the required angle by set screws, *c*, passing through slots, *d d*. It will be seen, too, in the figure that the framing is no longer carried around the horizontal rudders.

In the tail of the Model 1880 torpedo and earlier models is the mechanism for stopping after a certain run, and also that for suspending the action of the horizontal rudders. The first consists of the following arrangement: on the shaft of the forward propeller is an endless screw, *v*, engaging a toothed wheel, W, on whose face is a stud, *s*. At each rotation of W the stud *s* engages the escapement wheel W′ and moves it one tooth. The wheel W′ is restrained by the spring *p′* and has on its face a stud, *s*. After a certain number of escapements of W′ the stud *s′* comes in contact with the trigger *t*, and, turning it about the axis *x*, causes the notch *u* to release the box X surrounding the shaft and containing the spring *p* under compression. This spring, acting between the after flange of the box and a collar on the shaft, causes the former to jump backwards, dragging with it, by means of a lug *u″*, the rod *d*. This, by means of the connecting rod *e* (Fig. 2), the bell-crank *i*, *k*, and the link *m*, pulls forward the lever L and closes the starting valve.

To recock the apparatus a hook is inserted in a slot in the tail stock and the lug *u″* dragged forward until the notch *n* drops over the rear edge of the box X.

The slot *j*, Fig. 2, in the rod *e* allows the lever L to be thrown back as the torpedo leaves the launching tube without hindrance from the stopping mechanism, but if the latter is not set as described it can readily be seen that the lever L will not be thrown back and the torpedo would simply lie where it fell upon the water.

The escapement wheel W′ is graduated on its face as shown in order that it may be set to stop the torpedo after a run of any desired distance. How to set this wheel, should no table be available, may be obtained as follows: multiply the mean pitch of the propellers, minus the per cent. of slip, by the number of teeth in the wheel W; divide the distance the torpedo is to run by this product, and the quotient will be the number of teeth in the wheel W′ which must be traversed between the stud *s*′ and the trigger *t*. Of course the mean pitch of the propellers must be expressed in the same denomination as the distance to be run by the torpedo.

The mechanism for restraining the action of the horizontal rudders is to protect them from the initial vagaries of the pendulum due to inertia and shocks upon launching. To this end an arm, M, free to turn about the axis *x* independent of the trigger *t*, has attached to it a claw, C, pressed downwards by a spring, *p*″. Also attached to the arm M is a system of rods, *y*, *z*, which, in the machinery chamber, are connected to one end of an athwartship lever, *l*′, Fig. 3, on a vertical axis, *x*′; the other end of the lever having a flat edge, *k*′, and fitting into a pair of jaws, *j*′, Fig. 4, on the vertical rod I. This rod, therefore, can not move until the stud *s*, Fig. 1, on the wheel W, engages the claw C and drags back the arm M and the rods *y*, *z*. The latter, acting upon the athwartship lever, withdraw its farther end from the jaws of the rod I and allow the immersion regulators to act upon the horizontal rudders. Once back, the claw C is inoperative, simply rising and falling each time the stud *s* passes it. This stud is adjusted by turning the wheel W (through the medium of the propellers) by hand. Its proper position varies with the mode of launching and in different models.

The jaw *j*′ is adjustable along the rod I, so that the horizontal rudders can be rendered inactive at any inclination with the plane of their frames. Thus, not only can the *duration* of their inactivity be controlled, but their *position during* inactivity. Such adjustment has been found by experiment to be beneficial in guiding the torpedo more quickly to its plane of immersion, and an empirical table or curve of inclinations for different models and modes of launching is furnished.

In actual warfare it is desirable that a torpedo which has missed its target shall neither fall into the hands of the enemy nor float about as a danger. To this end a sinking arrangement is devised. It consists of a bronze valve, Z (Plate VI, Fig. 2), kept seated in the machinery bulkhead by a spring, P, and having a rectangular grip, Z′, into which drops the hooked end of a rod, *y*, attached to the lever *k*. The rod *y* passes through the slot of a bent lever, U, fixed upon the axis of the cam lever L of the starting valve. The upper arm of the lever U, being a spring of lateral tendency, catches in one of the two notches on the edge of the slot *o* in the envelope of the torpedo. When in the forward notch, as shown in Fig. 2, the rod Y is lifted from Z′ and the arrangement remains inactive, but when in the after one the action is as follows: before launching, when the starting valve is closed, the lip *h*″ of the hook *h*′ (Fig. 2) rests upon Z′. When the lever L is thrown backward, as the torpedo launches from the tube, the rod Y, being drawn aft, allows the hook *h*′ to fall into the grip Z′ of the valve. Thus it remains until the end of the run, when the stopping arrangement, by closing the starting valve, as shown in dotted lines, opens the valve Z and floods the buoyancy chamber, causing the topedo to sink.

It is safer when practicing with a torpedo to remove the rod Y entirely; otherwise a mistake in setting it might cause the loss of the torpedo.

In the Model 1885 and later ones the stopping arrangement and that for suspending the action of the horizontal rudders has been transferred to the machinery chamber. The new stopping arrangement (Plate VII, Figs. 1, 2, and 3), consists as follows: a ratchet-wheel, A, Fig. 1, is fixed on a shaft, B, and turned by a rachet, L, worked by an eccentric on the main shaft A′. On the opposite side of the wheel is a detent, L′, and both rachet and detent are held against the wheel by the spring *p*. On the shaft B and abaft A is a screw thread, and also, at its rear end, a cam, G, Figs. 2 and 3. Parallel to B is another shaft, D, having keyed upon it, but free to slide along its length, a sector, E, with a screw-threaded periphery which engages the threads on B. On the rear face of the sector is a stud, H, and on its upper edge is a latch, P, which latches into the notched plates P′ and insures the periphery of the sector engaging the screw thread. Fixed on the same shaft D is a lever, *d*, which is connected to the starting valve lever by a connecting rod, F.

When the propellers are set in motion the eccentric on A″, Fig. 1, causes the wheel A and shaft B to rotate; the screw thread on B carries the sector E aft until the latch P clears the notches in the latch plates P′. Then the revolving cam G comes in contact with the stud H on the after face of the sector, lifts it and the lever *d* about the axis of D, and, through the medium of the connecting rod F, Fig. 2, closes the starting valve. The sector E then springs forward along D under the action of the spring R, which is secured aft and doubled back over the roller *p* to secure to the lug *e* on the sector.

When the starting valve is opened, as the torpedo is launched, the sector is latched into P′. Before placing the torpedo in the launching tube the sector can be set for a desired run by pushing the sliding leaf *m*, Fig. 2, which is in contact with the lug *e*′, along a longitudinal groove, *v*, in the torpedo envelope. The edge of this groove is graduated for different runs.

The shaft B extends forward of the wheel A, Fig. 3, and has fixed on its forward end a pinion, *a*, Figs. 1 and 4, which works the arrangement for restraining the horizontal rudders. This consists of a bronze sector, J, Fig. 1, pivoted at j^3, and having a flange, j, on its periphery, and also, pivoted to it on a stock at j', a rack, K. The spring o tends to press the rack and sector always to the right and to keep the teeth of the rack always up against the pinion a. To set this apparatus move the horizontal rudders by hand to bring the jaws j'' on the vertical rod I in line with the flange j. Then insert a key, through a hole in the torpedo envelope, into a socket in a lug, t, on the sector J, and push the latter to the left. The flange j enters the jaws j'', and the rack K engages with the pinion a. The rod I is thus held immovable until, by the rotation of the propeller shaft A′, the rack K, released tooth by tooth and forced to the right by the spring o, pushes the sector to the right until the flange j clears the jaws j''. The duration of immobilization can be regulated by the set screw T working in the lug s on the rack, for its head, T′, bringing up against the pinion a when the sector J is set, limits the arc of j engaged by the jaws j''.

The sinking valve in these later models is inclined in the machinery bulkhead, but its mode of action is unaltered.

The following is an abridged, but not otherwise altered, description of the Howell automobile torpedo now being manufactured for the United States, furnished us by Mr. E. W. Very, of the Hotchkiss Ordnance Company:

PLATE VIII.

The general profile of the Howell torpedo is that of a spindle of revolution, the after body being a true spindle, the middle body a cylinder, and the fore body an approach to an ogive. There are four distinct detachable sections: the nose A A, which carries the firing pin and its mechanism; the head B B, which carries the explosive charge and detonator; the main section C C, which carries the fly-wheel and screw gears; the stern section D D, which carries the diving mechanism.

THE NOSE.

(Plate VIII, Figs. 2, 3, and 4.)

In order to guard as completely as possible against a premature discharge of the torpedo in handling, the percussion firing pin is so arranged as to be completely removable and also to be quickly attached at the last moment before inserting the torpedo in the launching tube. The entire firing pin mechanism is therefore permanently fixed in a single hollow bronze casting, 17, 17, which is attached to a projecting lip at the front end of the head by a simple bayonet, or slotted screw, joint, so that a few seconds only are necessary to attach and detach it. A stout steel pin, 18, travels in guides formed in the nose casting, and is actuated by a strong spiral spring, 19. It is held back in the armed position by a soft metal pin, 20, which seats in a slot cut through the pin and bears against the outside of the nose. The outer end of the firing pin is provided with fan-shaped corrugated horns, 21, which receive the impact blow, and are so shaped and arranged as to prevent glancing or sliding along the object struck when the impact is sharply angular. The force of the blow is intended to shear the soft metal stop-pin, and thus permit the firing pin to be driven violently down on the detonator by the spring.

Two small cams, 22, 22, are so pivoted and maintained by the small flat springs 23, 23, that normally they rest against the body of the firing pin just under a shoulder, so that if from any accident the pin after cocking should be so struck as to shear the soft metal stop-pin, it could not drive down and explode the detonator. Just in front of the cams is a cross-head, 24, having projections which rest on the cams so that as the cross-head is pushed to the rear the cams are turned out clear of the shoulder, leaving the firing pin clear. The cross-head is in connection with two small pistons, 25, 25, which are held forward by the cam springs. The front ends of these pistons come out flush with the outer surface of the nose and are entirely open. When, after launching, the torpedo strikes and rushes through the water, the direct pressure on these pistons forces them back against their springs, in turn pressing on the cams and turning them back clear of the firing pin, which is then completely armed for action. When the speed of the torpedo becomes so reduced as to permit the piston springs to overcome the pressure of water on the pistons, they come forward, the cams turn in under the shoulder, and the firing pin is again locked. The condition of the firing pin is at all times plainly visible. The length of the firing pin projecting beyond the nose shows whether it is cocked or not; the piston heads being plainly visible show at all times whether the cams lock the pin or not.

When the nose is off the head, the front of the interior of the head is laid bare, so that the detonator itself may be kept out of the torpedo until the last moment. Small holes, 26, inclining strongly backward, are pierced through the nose and are left open. These holes leak water into the hollow nose chamber when the torpedo is stationary, or at low speed, which overcomes the reserve buoyancy of the torpedo, sinking it and finally attacking and drowning the dry gun-cotton detonator; so that if the torpedo fails to make a hit it locks its firing pin, and sinks and drowns its detonator, being thus rendered completely innocuous.

THE HEAD.

(Plate IX.)

The heads are distinguished as the dummy head and the fighting head. The shells of both are made of a single sheet of brass brazed and spun to shape and braced by strong rings, A A, B B, at the front and rear ends. Each of these rings is prolonged slightly beyond the end of the shell to form bayonet joint locks, the front one for holding the nose, the rear one for securing the main section.

The dummy head carries a heavy wooden block, C C, quite filling the interior space. This block has a square hole cut through its axis and carrying an iron, threaded bar, D D. Upon this bar is a square lead block, E E. The outer end of the bar being squared, it is readily seen that by turning it the block is traversed back and forth. By this means the torpedo is balanced longitudinally. When the torpedo is launched, no matter whether it has buoyancy or not, its diving mechanism will keep it at its proper depth. It is desirable that the greatest weight of explosive possible should be carried and also that it should sink at the end of its run if it fails to make a hit. Therefore with the fighting head the buoyancy is practically *nil* and the torpedo is permanently balanced in its entirety for this condition. For exercise, however, the torpedo must not be allowed to sink, as it would be lost. The dummy head, therefore, is lighter than the fighting head, so as to give about 13 pounds buoyancy, and the lead block is introduced in order to keep the center of gravity of the torpedo in the same position relatively to the center of buoyancy as that occupied with the fighting head. Otherwise there would be a difference of leverage between the two conditions that would alter the steering adjustments. A single shop adjustment of this block is sufficient, and it maintains its place unless moved by screwing the bar.

A complete bulkhead plate screws water-tight into the rear end of both heads.

In the fighting head the main part is completely filled with wet gun-cotton; a small water-tight chamber, F F, formed of a single piece of drawn copper, being reserved for the dry gun-cotton primer. This chamber is removable, having a flange, G G, at its mouth which seats on a diaphragm, H H, screwed across the mouth of the front casting by means of a ring, I I, screwing down on a rubber gasket. A cap, K K, covers the primer chamber, being held in place by spring catches L L, and forming also the seat for the detonator M, which is held in place by the spring catches N N.

By this arrangement the detonator may be removed, and as the dry primer is contained in a thin tin case it also is readily removable, leaving the head with only the wet gun-cotton charge, which itself is at all times hermetically sealed in proper shape for stowage in a magazine, the primer and the detonator also stowing separately in their own magazines.

Two small holes, 0 0, are drilled through the cap of the primer compartment and are filled with a substance that is soluble after long contact with water. As above explained, the holes in the nose admit water at the end of a run. The water attacks the composition, filling the holes in the cover, and after a number of hours dissolves it out, and so drowns the dry gun-cotton primer.

THE MAIN SECTION.

(Plate VIII.)

This section comprises the entire cylindrical body of the torpedo and portions of the curved part at either end. The shell consists of three sections of brass plate, corresponding to the cylindrical and curved portions, brazed and spun to shape. The section is closed water-tight at both ends and contains the fly-wheel with its frame, the propeller gears and forward sections of shafting, and the thrust bearings.

The shell is braced against deformation or crushing by six rib rings. There is a bulkhead ring, 1 1, which is flanged, and in which are worked the sockets of a bayonet joint, by which the head is secured to the main section. The flange of this ring is threaded and receives a complete water-tight bulkhead plate, 6. As has been described, there is also a complete bulkhead plate at the rear of the head. These plates naturally lie on either side of the joint, and when the sections are connected they are only about a hundredth of an inch apart. The space is so small that any leak that may occur through the joint does not admit water enough to be of any consequence, and so long as the joint is reasonably tight any water that may lie between the bulkheads is relieved from the pressure due to immersion, so that it will not be forced past their joints. The torpedo has been sunk to a depth of 40 feet without showing any signs whatever of leakage.

Two intermediate rings, 2 2 2 2, are inserted under the brazed joints of the shell. These are simply plain, flanged, bronze rings. Two rings, 3 3 3 3, support the midship section, and at the same time form a part of the assemblage of the wheel frame, the other members of the frame being two plate castings, 4 4 (shown in section Plate X, F F F F), forming the bearings for the fly-wheel, which are bolted to the rings. Finally there is a rear bulkhead ring, 5 5, which, like the front one, holds a complete bulkhead, 7 7, and also forms the seats for the thrust bearings 8. It is impossible to connect the main and stern sections by a bayonet joint on account of the screw-shafts which prevent the twisting necessary to lock the joint. The strengthening ring of the stern section, therefore, has a lip which fits into an under cut in the flange of the main section ring and is held by screws, S S S. As this joint comes in the compartment containing the diving mechanism, which must be free to water access, it is not necessary that it should be water-tight.

THE FLY-WHEEL AND ITS CONNECTIONS.

(Plate X.)

The fly-wheel A A A A is of gun steel, drop forged and treated similarly to the tube and jacket forgings of guns. It has a heavy rim with a solid web connecting it to the hub. Secured to the hub and symmetrically placed on each side of the web are two steel miter-wheels, B B

B B, which gear into similar wheels, 9 9, Plate VIII, secured to the inner ends of the screw shafts, the proportion of gearing being as five to four, so that each screw makes 800 revolutions to every 1,000 of the fly-wheel. The axle of the fly-wheel C C C is a single solid steel axle, permanently secured in its seat in the wheel; its bearing ends resting on hard steel rollers D D D D, in hard steel bearings E E E E, which themselves seat in sockets cast in one with the frame plates F F F F. The inner ends of the bearings E E, and the bodies of the miter-wheels facing them, are grooved and hold steel balls G G G G, forming ball-bearings to take the end thrust of the fly-wheel. Thus the wheel is provided with frictionless bearings, no matter what be the plane of the axle when rotating.

The connection between the fly-wheel and its motor, which forms part of the launching gear, is made through the starboard side of the torpedo by means of clutch couplings to the end of the axle. The right-hand end of the axle is squared and carries pinned on it a steel end-clutch, H. A loose clutch, I I, is held in a stuffing box, K K, seated in a prolongation of the frame plate which bears against the shell of the torpedo, a through-hole being cut in the shell and the joint being closed water-tight. This loose clutch, I I, is so made in order to free the fly-wheel from the friction of the clutch in the stuffing box. After spinning up the wheel, the moment that the motor is unclutched this loose clutch commences to hang back, from its friction in the stuffing box. This brings the rear sides of the clutch studs in bearing, and, as they are cut with a deep slope, the clutch is instantaneously driven out free of the wheel.

In order to preserve the balance of the torpedo the left-hand frame plate is carried out to the shell in the same way as the right-hand one. The interior of this projection is threaded and a lead disc, L L, is screwed in to counterbalance the clutch and stuffing box on the right-hand side. By means of this lead disc alone the entire torpedo is balanced transversely, for a small hole is tapped through the shell, through which a key may be inserted and the disc may be screwed in or out to make the necessary adjustment. Once made it remains of itself.

The screw shafts proper end at the bearing 10 (Plate VIII), being secured to the axles of the miter-wheels, 9 9, by a mortise and tenon connection. This is done to prevent any skew tendency in the miter-wheel being transmitted to the shaft, and to enable the shafts to be entirely disconnected from the contents of the wheel frame. In order to neutralize the skew tendency of the miter-wheels, their short axles are held in close bearings in front of and behind the wheels, these bearings forming a part of the wheel frame castings so as to remain constantly true. The screw shafts are carried straight to the rear through the box 8, forming a part of the rear bulkhead ring, and within which are the thrust bearings and a stuffing box, made necessary by the proximity of the free water compartment. The thrust bearings being placed here relieve the miter-wheels of all thrust, and more room is allowed to make stout bearings than if they were placed farther aft.

A broad, stout plate, 11 11, is soldered to the bottom center of the shell, to which, on the outside of the shell, is bolted a long stud, 12 (S, Plate ~~II~~X). The function of this stud is to center and guide the torpedo in the launching tube.

The composition of the thrust bearing and stuffing box is as follows: Long seats, *a a* (Plate VIII, Fig. 5), are cast in one with the rear bulkhead ring, over which screw caps, *b b*. The shaft is slightly increased in diameter at the point *c*, forming a seat for the steel bearing ring, *d d*, which has a companion bearing ring, *e e*, seated against the sleeve. Steel balls lie between these rings, thus forming a ball bearing. A bronze spanner clasps each of the caps and prevents them from unscrewing, while at the same time it resists any tendency to flexure or spreading of the shafts.

A small bronze loose sleeve, *f f*, is slipped on the shaft and lies in the stuffing box section. This sleeve is pierced with holes and its ends are packed. In this way the stuffing box is formed and at the same time provision is made for oiling the bearings, for the oil coming down on the sleeve passes through the holes and is absorbed and distributed by the packing.

THE STERN SECTION.

(Plate VIII.)

The stern section is divided by a water-tight bulkhead, 13, 13, 13, into two compartments, the forward one containing the diving mechanism and being open to the free access of water through the inlet holes E, E, E, pierced through the shell, whilst the rear compartment is closed water-tight, and is empty save the sleeves passing through it, within which are the screw shafts and tiller rods. The rear end of this section is closed by a casting called the tail piece, 14, which forms in one the butt of the tail and the screw shaft tubes with their cross-support F, F, F, F. The screw shafts are taken in bearings in the tubes F, and the screw propellers, which are right and left handed, are screwed to the ends of the shafts, being held fast by end nuts, G, G, which are shaped off in long cones to give a fair run to the water passing the hubs. The triangular spaces H, H, between the tail body and the screw shaft tubes, are covered with plates in order to give a fair flow of water to the rudder and screws. The small chambers thus formed also give additional buoyancy.

The rudder I, I, is a steel rectangular plate completely filling the space between the outer ends of the screw shaft tubes. In this position it is secure against damage in handling the torpedo, and fouling in running. A stout web 15, 15, stands at right angles to the plane of the rudder, forming a steering yoke, to the ends of which are pivoted the tiller rods 16, 16, which in turn are directly connected to the diving mechanism.

THE DIVING MECHANISM.

(Plate XI.)

The bulkhead A, A, A separates the rear and water-tight compartment from the diving compartment, both being in the stern section. It is a single casting so shaped as to reduce the water space to the least possible dimensions consistent with the working of the mechanism, and has a broad flange seating on the shell to form a stout stiffening member of this part. The bulkhead B, B, B, which is the rear bulkhead of the main section, forms with A, A, A a complete water chamber. The tiller rods C, C, C, C are pivoted to the rudder yoke D, D, and pass inside of sleeves through the water-tight compartment and bulkhead, their inner ends pivoting directly to their respective parts of the diving mechanism, the upper rod being attached to the hydrostatic piston E, E, and the lower one to the compound lever of the pendulum, F, G, H. These tiller rods are provided with screw junctions I, I, for taking up lost motion and regulating the angle of the rudder.

The forward compartment being in free communication with the exterior water the pressure due to depth of immersion is fully borne on the piston E, E. This piston fits loosely in its cylinder, K, K, which is secured to the bulkhead by the posts and nuts L, L. The posts are made hollow and connect with the interior of the cylinder so that there is free air connection between the space in the cylinder behind the piston and the whole air space in the rear compartment, so as to prevent any back pressure on the piston. A rubber disc covers the piston and is held water-tight about its edges so as to prevent water getting into the cylinder and at the same time offer no opposition to the free movement of the piston.

Near the front end of the lower tiller rod a seat M, M is fastened to it, against which abuts the forward end of a powerful spring whose rear end seats against a movable sleeve N, N. This sleeve screws into the rigid main sleeve of the rod, and a key may be used on the end outside the torpedo to screw it in or out and so alter the tension of the spring which alters the depth of immersion.

Assume that the depth at which it is desired to run the torpedo is 10 feet and that at that depth the total pressure on the hydrostatic piston due to the head of water is 100 pounds. The rudder being held amidships let the spring be adjusted to a tension of 100 pounds. Since the tillers are directly connected, the one to the piston and the other to the spring, it follows that if pressure of 100 pounds be brought on the piston the tension of the spring will be balanced and the rudder will lie amidships. This will occur at the assumed depth of 10 feet. If the immersion be less there will be less pressure on the piston and the spring will hold the rudder partially down and so steer the torpedo down to its proper depth, and *vice versa*. The tension of the spring varies inversely as its length, whilst the pressure on the piston varies directly with the depth. Therefore the helm is not thrown hard up or hard down as the torpedo departs from its proper depth, but it is eased over the proper amount to bring the torpedo easily to its proper depth. The point at which the helm is thrown hard over depends upon the length and strength of the spring.

As a matter of course the torpedo will always move in the direction of its longitudinal axis. Whilst, therefore, through the action of the hydrostatic piston, the rudder will be brought to a neutral position at the proper depth, the torpedo must be horizontal at that depth, or it will continue to go down or up, according to the direction in which it points. The piston can not correct the direction of the axis of the torpedo except secondarily. It is therefore necessary to introduce a heavy pendulum, H, suspended so as to swing in the fore and aft line of the torpedo. Whenever the axis of the torpedo dips down or up the pendulum swings forward or aft. The bob of the pendulum, which is very heavy, is mounted on springs, O O, on its suspension rods, so that when the torpedo strikes the water in falling from a height the shock on the suspension points will not be too severe. The pendulum is connected to the front end of the lower tiller rod by a compound lever, F F, so as to increase its power. Assume that the torpedo is at its required depth, its axis horizontal, and its rudder amidships; leave for the moment out of consideration the action of the hydrostatic piston, and assume that from any cause the bow of the torpedo is tilted down. The pendulum bob at once swings forward and in so doing pushes the tiller rod back and forces the rudder up, thus tending to bring the torpedo to the horizontal again.

If the torpedo be pointed away from its proper depth line, and so long as it is leaving it, both piston and pendulum work the same way on the helm, and combine their efforts to turn the torpedo back, but when it turns back they commence to work against each other so as to ease it gently to its proper line, thus preventing violent oscillation.

A description of this torpedo is scarcely complete without including the launching tube designed by Mr. Elwell, the superintending engineer of the American branch of the Hotchkiss Ordnance Company; and the Dow Steam Turbine Motor, by which the fly-wheel of the torpedo is "spun up." These descriptions are also quoted from material furnished by Mr. Very.

THE CENTER PIVOT LAUNCHING TUBE.

(Plate XII.)

This gear is designed for open deck emplacements where all-around fire is permissible.

The discharge-tube is of bronze, bored to a diameter five hundredths of an inch greater than the midship diameter of the torpedo. It is mounted on a low broad cone, A A, whose base rests on a bed-plate, B B, bolted to the deck, the two being held together by a stout clip-ring, C C, so that the cone is free to revolve. A shallow groove, *s*, Plate ~~III~~,X is cut the full length of the tube along the bottom of the bore to carry the guide-stud of the torpedo. The rear end of this tube is closed by a door, D D, hinged to swing laterally, its inside edge being coned and ground to close air-tight. A steel cross-bar, E E, with a tightening screw, F, through its center, is carried by the same hinges as the door, the free end of the bar being held by a stout bronze loop, G G, when the door is closed. To lock the door, it is closed, the loop is swung over the end of the bar and a few turns are given to the tightening screws.

Two brass air tubes, H H H H, are secured to the main tube underneath, one on each side, being connected together at the front end by a cross-pipe, I. The tube on the right-hand side, called the firing tube, has screwed to its rear end a small bronze breech-piece, K K, which is chambered to carry an ordinary metallic cartridge-case and has a simple breech-block, L L, in which is fitted a hammer, sear, and main spring. The weight of powder used is less than half a pound, with which a discharge speed of over 35 knots can be obtained for a torpedo weighing nearly 500 pounds. The front ends of both air-tubes are closed by screw-caps, M, that may be removed whenever necessary to sweep out the tubes. It will be noticed that the forward end of the firing tube is extended well beyond the cross-duct I. This is done in order to form a lodgment for bits of wad or unburned grains of powder that by the explosion will be driven past the duct and be caught and held in this space precisely as is the case with the cinder-trap of a locomotive engine.

The rear end of the left hand pipe, called the compression-pipe, connects by an elbow with the main tube. Around the rear of the main tube is secured a hollow strap, N N, into which the elbow of the compression tube opens. The wall of the tube underneath this strap is pierced all around with small square ports cut at an angle such that the blast of air created by the explosion of the charge will be directed against the door of the tube first, instead of being taken directly on the tail of the torpedo. The air pressure thus created in the main tube drives the torpedo out. At a speed of ejection of about 35 knots, a torpedo discharged at a height of about 5 feet will take the water fully 30 feet from the ship's side.

The Dow motor is attached to the main tube on its right side, a hole being pierced through in the clutch line. The steam pipe O O, and the exhaust pipe P, to and from the motor, are carried down into the supporting cone, where a junction box is made so that the steam pipe goes through the deck inside of the exhaust. This junction is swiveled to permit the system to revolve.

A throttle valve, with a hand wheel R R, gives steam, which is controlled by a regulator valve, S, and there is also connected to the throttle an automatic cut-off.

The small box V is a steam cylinder, whose piston projects up through the main tube into and filling the slotway for the torpedo guide-stud and forming a stop. This piston is held up by a spiral spring underneath it. To load the torpedo into the tube it is simply necessary to push it in until its guide-stud brings up against this stop, and then close and fasten the door. The clutch hole in the torpedo is then directly in line with the motor-clutch, and the moment that these clutches are thrown in action the torpedo is held firmly against all movement.

A long rod W W performs the work of clutching, disconnecting, and firing. The torpedo being in its tube, the powder charge may be inserted. Lift the small spring latch X, open the breech, and insert the cartridge. It is to be remarked that unless the torpedo is clutched up ready for spinning it is impossible to cock the hammer, and unless the torpedo is entirely free to leave the tube it is impossible to fire. The action of firing itself is automatic and is controlled by the lever Q. By pulling back on the handle Y the long rod W W is drawn to the rear, clutching the motor to the torpedo and bringing the lever Q into position, so that the movement of closing the little breech cocks the hammer. If the throttle valve be now opened, steam is given to the motor and the fly-wheel will be spun up, it being possible to set the regulator valve that the wheel will run at any desired speed of revolution.

Discharge is operated in the following manner: A small box, Z, contains an arrangement by which a small steam valve may be operated either electrically or by a firing laniard. The valve works instantaneously and admits steam into the small pipe *a a* communicating with the stop-pin. Steam coming on the upper side of this little piston forces it down, so that the pin comes clear of the guide-stud on the torpedo, leaving it clear to leave the tube. As this piston descends, *and after withdrawing the stop*, a port is unmasked, admitting steam to the pipe *b b b*, passing to the cylinder T T, whose piston is attached to the long rod W W, driving it forward. As the rod moves forward, it first unclutches the motor, then cuts the steam off from the motor, and finally, at the end of its course, trips the hammer and fires the cartridge. Thus all the movements are performed automatically and they can only occur in their proper succession. The entire time from pulling the firing laniard until the torpedo leaves its tube is but little over one second, most of this time being taken by the torpedo itself gathering movement.

THE DOW STEAM TURBINE MOTOR.

(Plate X.)

Rotation is communicated to the fly-wheel by means of the Dow motor, which is a permanent attachment of the launching tube. The body of the motor is a small cylindrical box about 8.75 inches in diameter by 4.5 inches in depth. The shell consists of a bronze casting, *a a a a*, having covers *b b b b* through-bolted to it, which have projections cast in one with them to form bearings for the main shaft. Two discs, *c c c c*, screw permanently into the wall of the shell, having in turn two smaller discs, *d d d d*, screwed into and forming a part of them. The interior of the motor is thus divided into three chambers, of which the central one, *e e*, receives the live steam direct through the steam-pipe (not shown in the figure), and the two outer ones, *f f f f*, take the exhaust steam which passes out of the motor through the exhaust pipe *g*. The main shaft, *h h h*, is journaled in the bearings formed in the covers, and is given a longitudinal play, so as to permit clutching with and unclutching from the machine required to be driven. A sleeve, *i i*, covers the central part of the shaft, being keyed to it, but having a slight independent longitudinal play, and to this sleeve is secured a steel disc, *k k*, which partially divides the live steam chamber. Two bronze discs, *l l l l*, are also secured to the sleeve, and it is these discs that are revolved by the action of the steam, transmitting rotation to the main shaft.

Concentric ribs are cut on the opposing faces of the pairs of discs *c c c c* and *l l l l*, which intermesh, and through these ribs a number of angular slotways are cut, those on the stationary discs being at an opposite angle from those on the revolving ones. The live steam entering the steam space *e e* passes into the space *m m m m* and thence outward between the pairs of discs through their slotways, communicating rapid rotation to the revolving discs and shaft by expansion. After thus performing work, it passes into the exhaust chambers *f f f f* and out through the exhaust pipe. In passing through the slotways the steam undergoes seven expansions.

The function of the steel disc *k k* is to balance the work done by the two pairs of discs, since practically there are two drivers mounted on a single shaft. Assume that for some reason the right-hand disc is driven harder than the left-hand one. The over-pressure will force the right-hand disc, and with it the sleeve and other discs, to the right, and by this movement the steel disc partially closes the right-hand steam entrance to the chamber *m m*, opens and gives more steam to the left-hand one, and thus automatically equalizes the driving force on the two revolving discs.

The left-hand end of the main shaft ends in a clutch, *n*, and its journal, *o o*, is free to move longitudinally, carrying the shaft with it. The longitudinal clutching movement is communicated to the shaft by the stud *p*, which works in a guide slot cut in the starting gear (see Plate XII). The right-hand end of the shaft projects slightly beyond the end of the cover of the motor and is hollowed to receive the squared end of an auxiliary shaft which forms part of the tachometer.

THE ELWELL TACHOMETER.

The body of the support of this gauge is a brass casting, *r r r*, whose inner end forms a collar clasping the end of the outer shaft bearing and tightened by a screw bolt at *s*. The small hand-wheel *t t* attached to the auxiliary shaft does not belong to the tachometer, but is used when clutching up to engage the clutches. The cap *u u*, screwing over the outer end of the support casting, forms a small chamber connected with the gauge by the pipe *w*. Within this chamber and secured to the auxiliary shaft is a small cylinder having radial slits cut through it similar to the radial guides of a turbine wheel. As this cylinder is rapidly rotated these slits force the oil out against the sides of the chamber with a pressure proportional to the centrifugal force developed, which itself is proportional to the speed of rotation. The pressure is communicated through the pipe *w* to the gauge and acts on the pointer. The small conduit *x x* leads to an oil reservoir, *y y*, which keeps the pump chamber constantly full of oil.

z z are oil cups for supplying oil to the main shaft bearings of the motor.

From the foregoing descriptions three points in favor of the Howell torpedo are too evident to need comment, viz, the greater simplicity of its mechanism and its consequent inexpensiveness and usefulness in untrained hands. For other points in favor of one or the other of these two weapons we must compare actual torpedoes of successive periods and the results of their trials.

The first official trials of the Howell torpedo were carried out by the United States Torpedo Board in May, 1884. The torpedo was 8 feet long, 14 inches in diameter, weighed 299 pounds, and was designed to carry a charge of 50 pounds of gun-cotton. The Whitehead torpedo was then in the sixteenth year of its successful career and development, and the popular model was 14 feet long, 14 inches in diameter, weighed 560 pounds, and carried a charge of 66 pounds of gun-cotton. The following is a comparative table of these two torpedoes and their accomplishments:

1884.

	Length.	Diameter.	Weight.	Charge.	Speed.	Distance.	Direction.	Submersion.	Per cent. of charge to weight.
	Feet.	*Inches.*	*Pounds.*	*Pounds.*	*Knots.*	*Yards.*			
Whitehead	14	14	560	66	24	600	Fair	Good	.12
Howell	8	14	299	50	8.5	33	Excel'nt	V'y poor	.17
Difference	6	0	261	16	15.5	567	Howell	Whit'hd	.05

Thus we see that the Howell torpedo started in its competitive race with the important advantages of smaller size and consequent greater handiness; of much lighter weight even in proportion to its size; of a much greater proportion of explosive charge to weight of weapon, and, above all, in the possession of an unerring, self-maintaining directive force in the horizontal plane. On the other hand its submersion proved totally unreliable and its speed not worthy of contrast with that of its successful rival and wholly insufficient to make it an effective implement of warfare. The good points of the weapon were, nevertheless, decidedly encouraging, and its bad ones susceptible of improvement. Therefore, a year later, an improved model was brought out, and exhaustive trials were made with it in the United States. The following is a table comparing its results with the performances of a Whitehead of that year:

1885.

	Length.	Diameter.	Weight.	Charge.	Speed.	Distance.	Direction.	Submersion.	Per cent. of charge to weight.
	Feet.	*Inches.*	*Pounds.*	*Pounds.*	*Knots.*	*Yards.*			
Whitehead	14	14	560	66	25	433	Fair	Good	.12
Howell	9	14	284	60	15.6	200	Excel'nt	Poor	.21
Difference	5	0	276	6	9.4	233	Howell	Whit'hd	.09

Here we see that with but little change of weights and dimensions the Howell torpedo attained a speed which would have made it formidable at short range. The proportion of charge to weight is also improved. The Whitehead during the same time only shows one improvement, and that a doubtful one—an increase of 4 per cent. in uniform speed over a range shortened 28 per cent.

The submersion of the Howell was still poor and its speed and range still gravely inadequate as compared to that of the Whitehead. Yet its great possibilities of improvement were so evident that it soon passed into the hands of the Hotchkiss Ordnance Company for actual manufacture in Europe and the United States. Since then it has been experimented with and perfected without further official trials until the spring of the present year, when public trials were held at Villefranche.

During this period the manufacturers of the Whitehead have striven to their utmost to maintain the superiorities of their weapon and reduce its deficiencies, but in the latter respect their task has been difficult, for in order to meet the constant demand for increased speed and range, nearly the whole torpedo has to be taken up by the air reservoir and the steering and propelling mechanism. The torpedo has grown cumbersome and awkward to handle and the magazine space has been encroached upon. The latter evil is now to some extent counterbalanced by making the head extremely blunt, and this is in other ways an improvement, for it brings the bulk of the charge, and therefore the force of the explosion, nearer the point of impact, and, it is further claimed, enables the torpedo to glance under a net protection. That it would reach and explode against the ship's side after accomplishing this last feat is extremely doubtful.

The following is a table comparing the performances claimed for this type of the Whitehead with the results of the latest trials of the Howell at Villefranche.*

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* The model tried at Villefranche differs in many minor details from the one described in this article. The latter has not yet had an official trial.

1890.

	Length.	Diameter.	Weight.	Charge.	Speed.	Distance.	Direction.	Submersion.	Per cent. of charge to weight.
	Feet.	*Inches.*	*Pounds*	*Pounds*	*Knots.*	*Yards.*			
Whitehead	11.5	17.5	*725	110	29	437	Fair.	Good.	.15†
Howell	9.8	14	419	90	21	300	Excellent	Good.	.21
Difference	1.7	3.5	356	20	8	137	Howell	0	.07

*Estimated ; certainly not less. †Estimated ; certainly not greater.

Here we see in the Howell another increase in length and a considerable increase in weight, but a corresponding increase in weight of charge. In the Whitehead the length has been shortened, but at the expense of a large increase in diameter and weight. It is significant to note, too, that, although the head of this torpedo has reached the extreme of bluntness, the proportion of explosive charge to weight of torpedo has only been pulled up 3 per cent. This is apparently as far as this weapon, with its present mechanism, can be improved in its proportion of charge to weight. It is also apparent that, while the Howell torpedo has attained an uniformity of submersion equal to the Whitehead, the latter can never, without adopting the principle of the Howell, attain that certainty of rectilinear motion in the horizontal plane which is one of the most vital elements of success in a missile of destruction.

On the other hand elements of equal importance are speed and range, and the table shows us that, although the Howell has attained a very efficient average speed for a range of 300 yards, it is still considerably behind its rival in both requisites.

There are some points not shown in the tables which are worthy of careful consideration. The speeds given for the Whitehead are *uniform* over the distances set down beneath them, while the speeds for the Howell are the average speeds, the velocity of the latter steadily decreasing from the moment it is discharged. This *uniformity of speed* is claimed as an *advantage* for the Whitehead. Be that as it may, it is really a *necessity* in order that that torpedo may maintain its submergence and direction. The moment its speed begins to decrease the torpedo rises toward the surface and its course becomes erratic.

Another consideration, too, against the Whitehead, is the possibility of its air reservoir being exploded, before the torpedo is launched, by an enemy's shot. When it is recollected that the pressure in this reservoir is over 1,000 pounds to the square inch, and that the concussion might also explode the charge, the magnitude of such a disaster can be appreciated.

In order to obtain its speed the fly wheel of the Howell has to be "spun up" to 9,000 revolutions per minute by a machine separable from the torpedo before launching, and these revolutions must be maintained by the external machine during any delay in launching. The Whitehead, on the other hand, is in a state of constant readiness to be launched. This advantage in favor of the latter is less apparent upon closer investigation, however, for, although it takes nearly two minutes to obtain 9,000 revolutions per minute on the fly-wheel of the Howell, a very appreciable interval in battle, there will almost always be much more than two minutes warning of an approaching combat, and it has been easily demonstrated that the rotation can be maintained for an indefinite period, thus placing the torpedo in a condition of constant readiness for a first discharge at the opportune moment. These opportune moments in battle are but moments, and the intervals between them will no doubt always exceed the time necessary to "spin up" for another shot. On torpedo boats the disadvantage of this *preparing interval* disappears; for, after a first discharge of the *ready* torpedoes, the boat would never remain under fire of machine guns to reload and try again, even if it took but the time necessary to insert the torpedo in the tube.

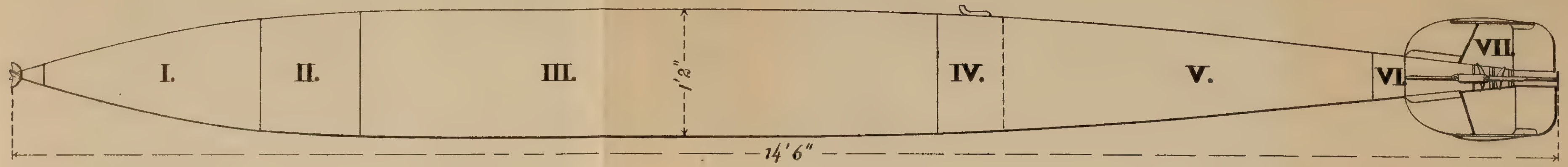
We therefore see that in the possession of the four vital elements of success in a missile of destruction, viz, *velocity*, *range*, *rectilinear direction*, and *rending force*, the Whitehead torpedo at present exceeds the Howell in the first two by 30 per cent., while the latter exceeds the former in the last requisite by the same percentage and is much superior to it in the possession of the third element. Thus the merits and defects of the two seem to balance one another very closely, and in their present stage of development only their actual use in battle could demonstrate which is the superior weapon.

This much more can be said for the Howell, however. Its deficiency in speed seems to be due to an imperfect utilization of its motive power, and may therefore be made up in time by a reduction of friction, different pattern and arrangement of screws, modification of its shape, or by a combination of these changes, and the range will improve with the speed. On the other hand the defects of the Whitehead, with its present scheme of propulsion and directive power, appear insurmountable.

It is stated upon authority that the future Howells are to have blunt heads, and that Whitehead is experimenting with a motor on the gyroscopic principle. The time may not be far distant, therefore, when one or the other of these companies will produce a torpedo possessing all the good qualities of both.

PLATE I.

WHITEHEAD TORPEDO, MODEL 1880 MODIFIED.



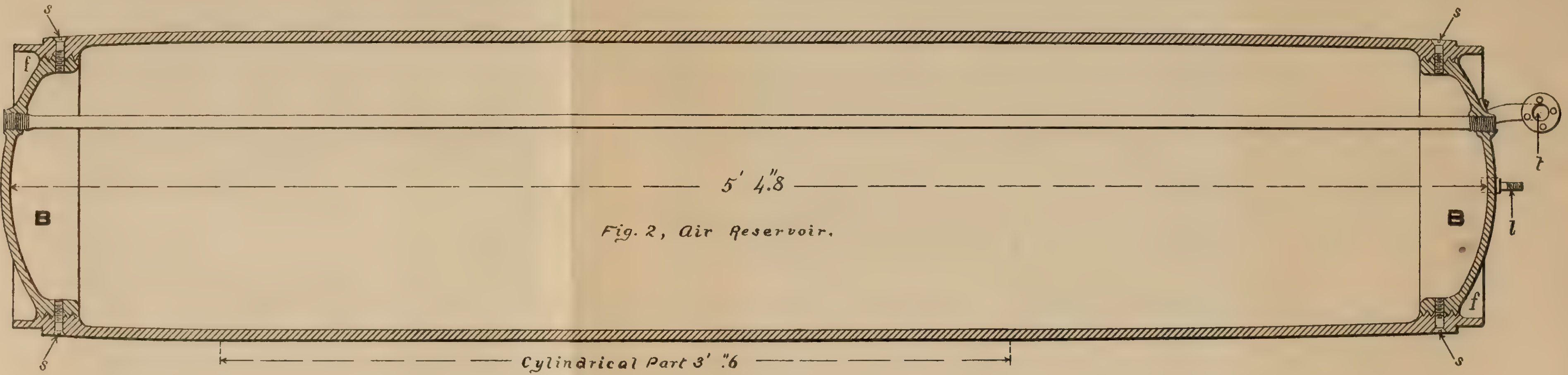


Fig. 2, Air Reservoir.

Fig. 3, Rear Cone.

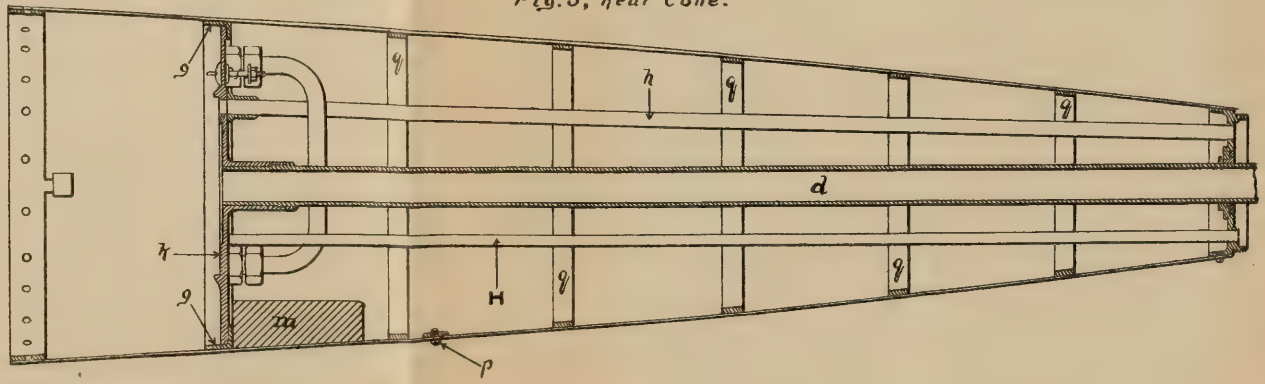


PLATE II.

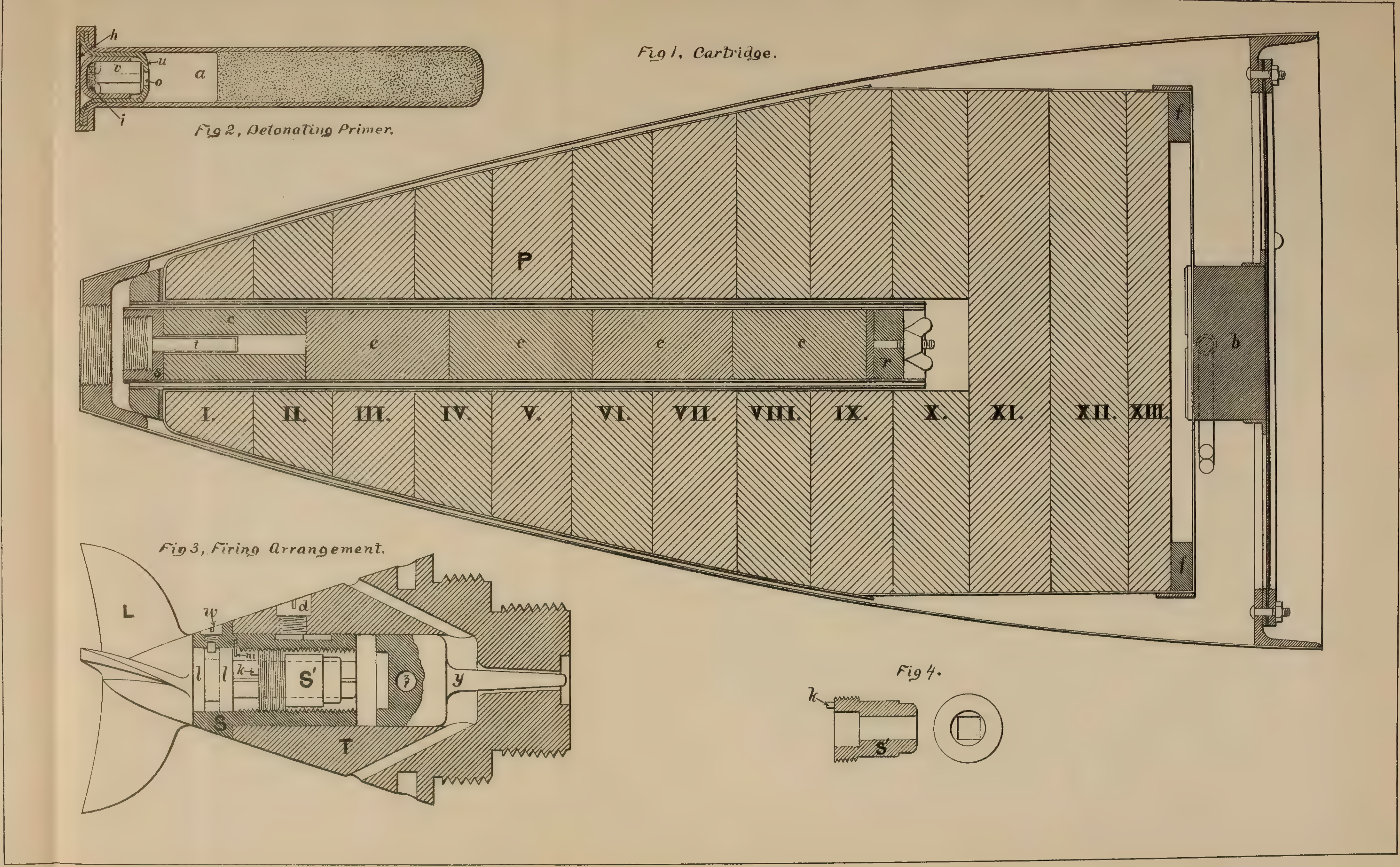


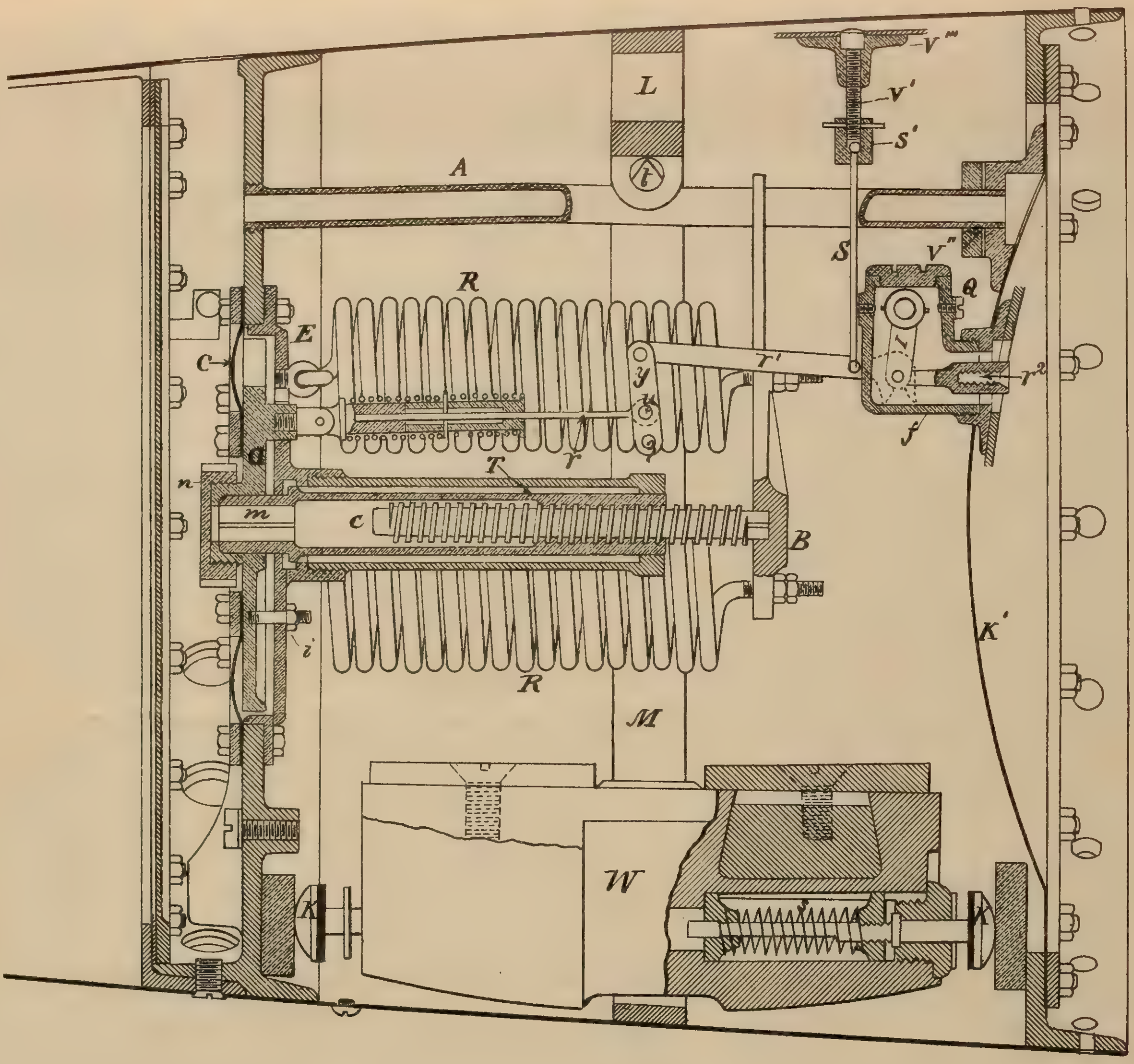
Fig 1, Cartridge.

Fig 2, Detonating Primer.

Fig 3, Firing Arrangement.

Fig 4.

Secret Chamber.



Servo-Motor.

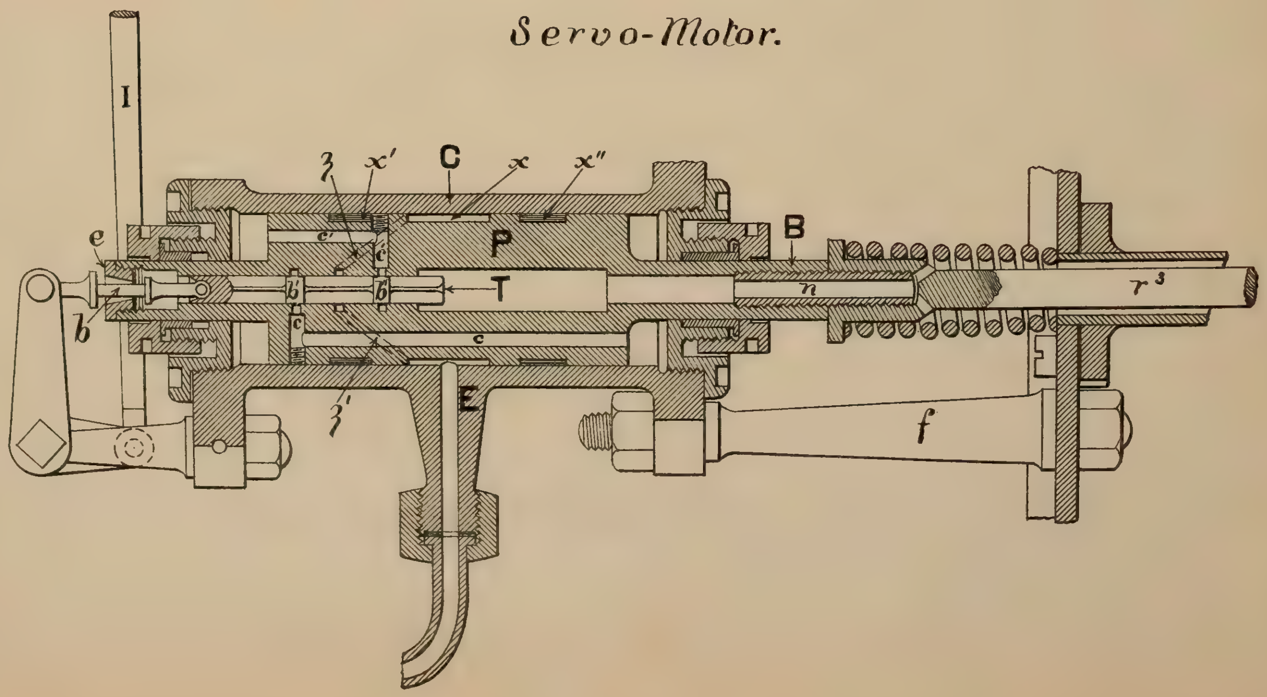


PLATE IV.

Whitehead Engine

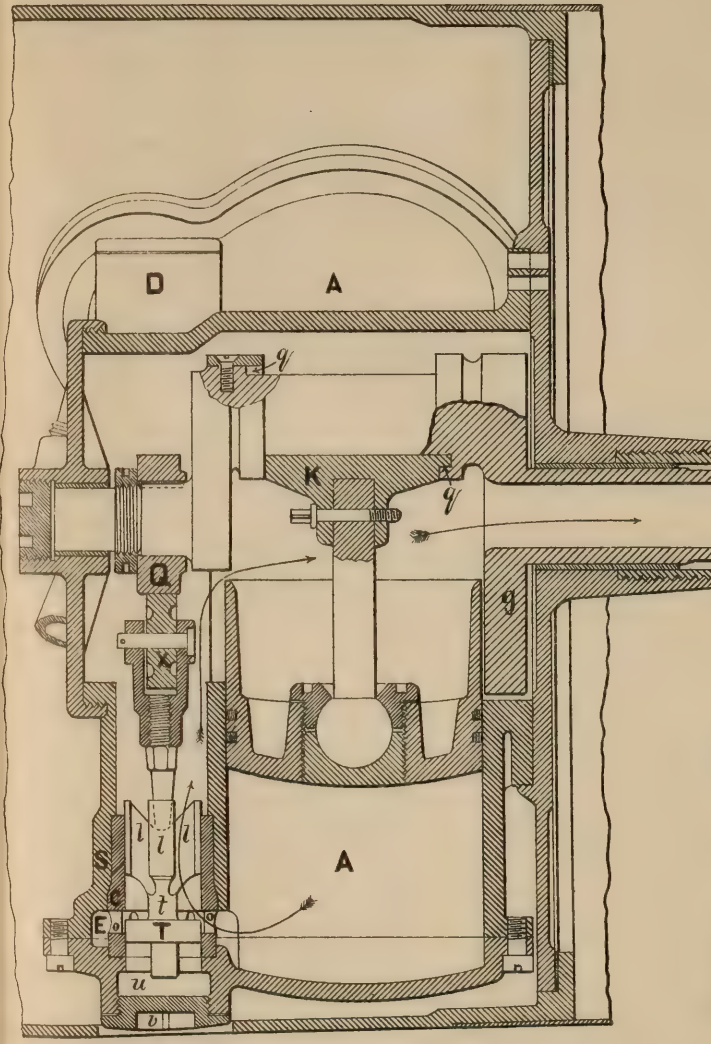


Fig. 1

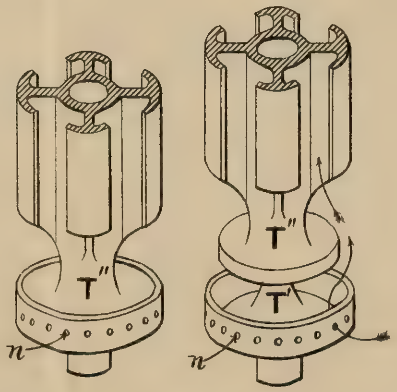


Fig. 3

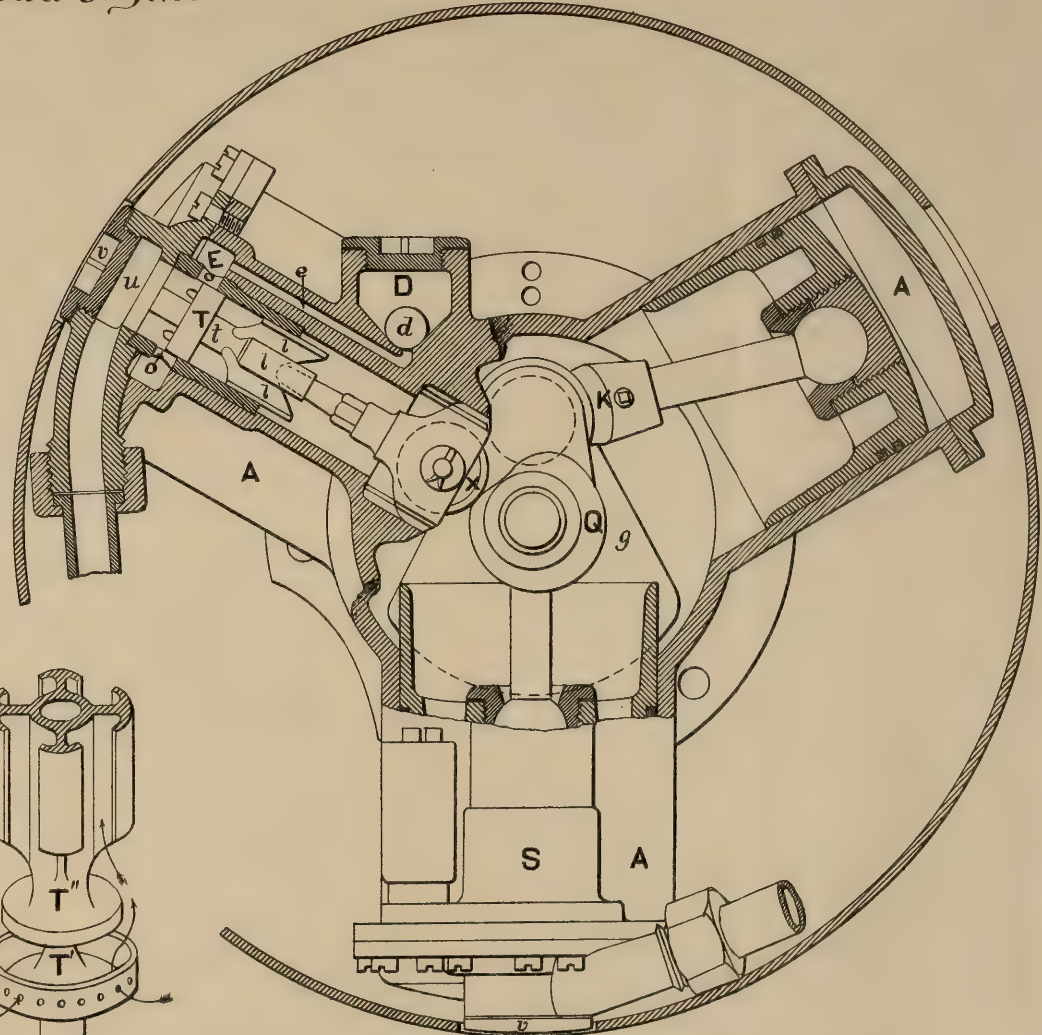
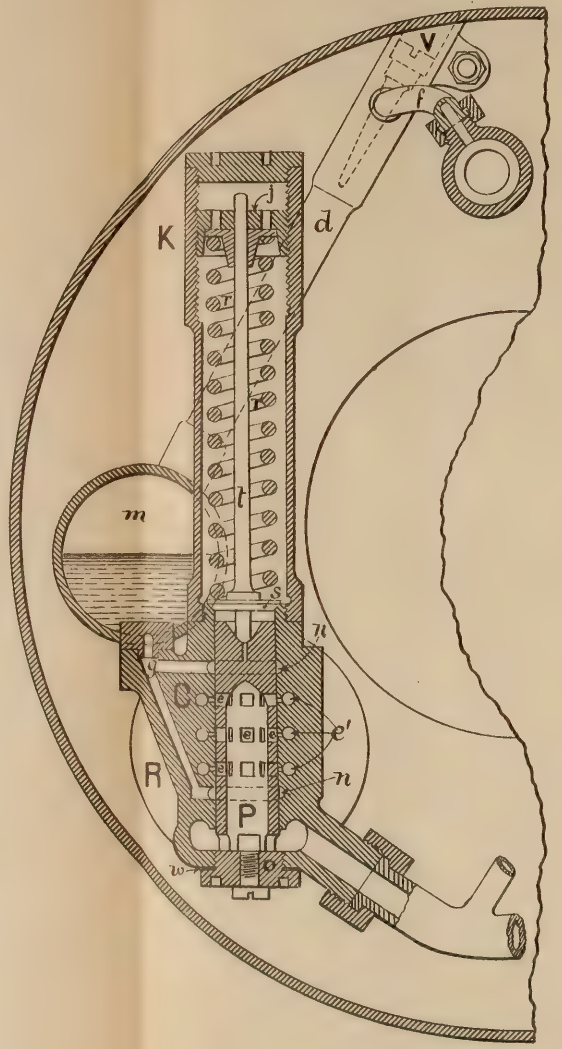


Fig. 2

Pressure Governor



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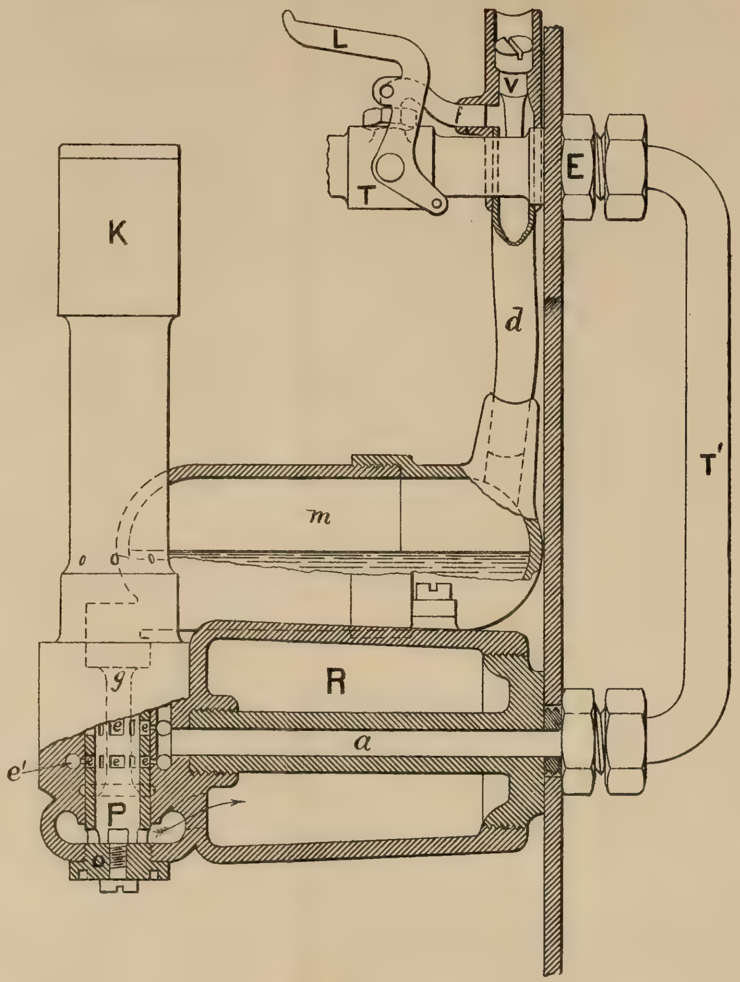


Fig 2.

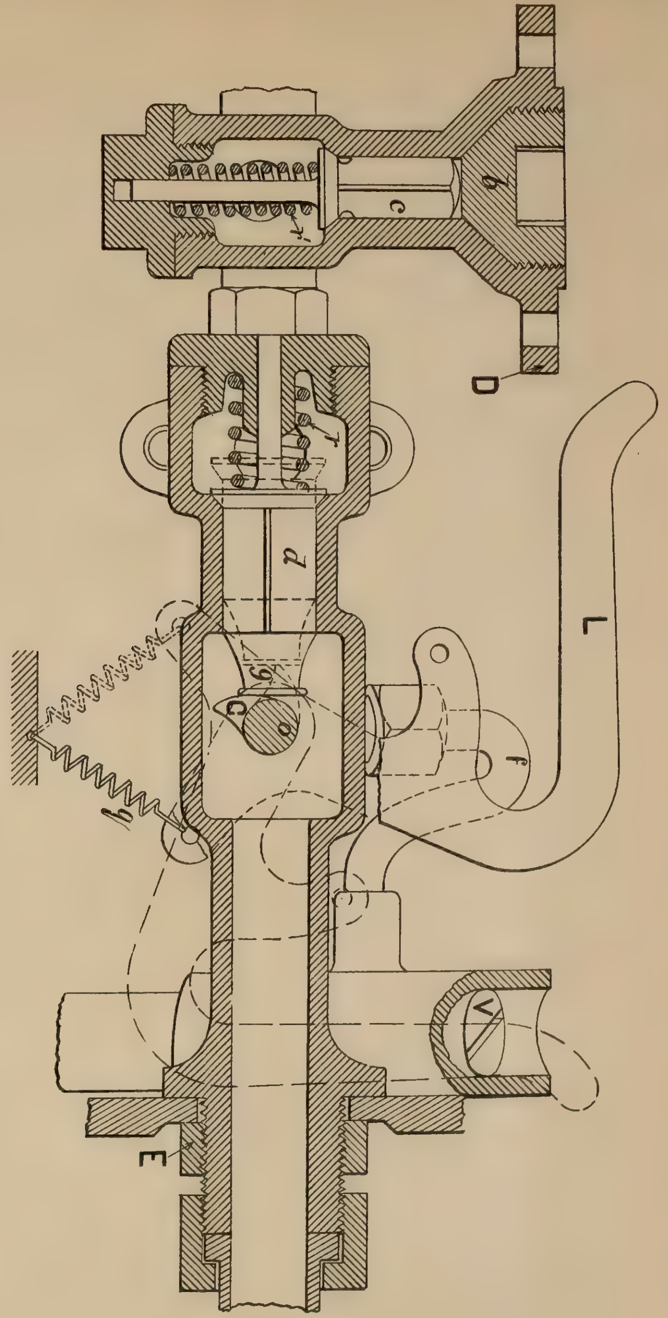


Fig 3, Starting Valve

Bevel Gear Chamber and Tail.

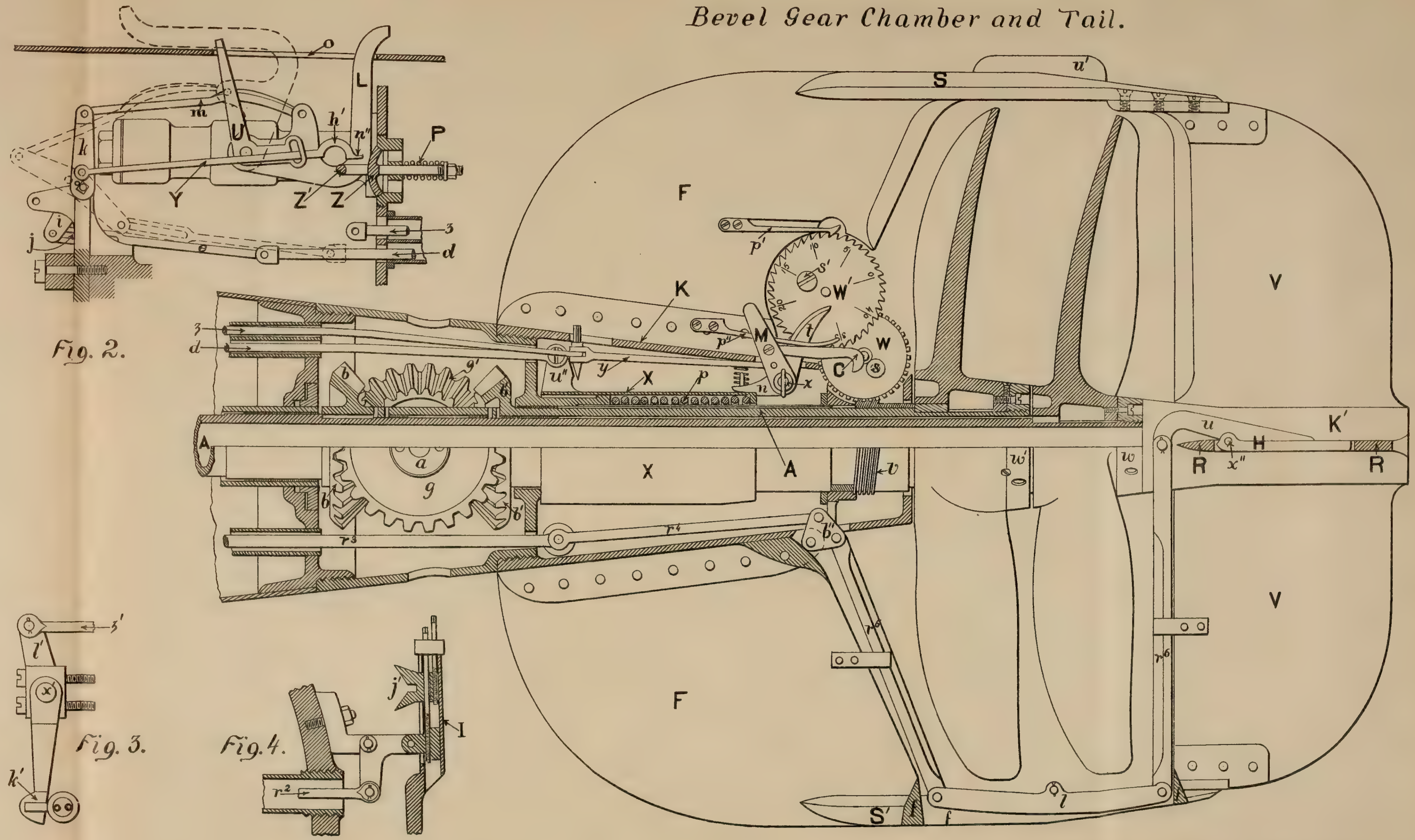


Fig. 2.

Fig. 3.

Fig. 4.

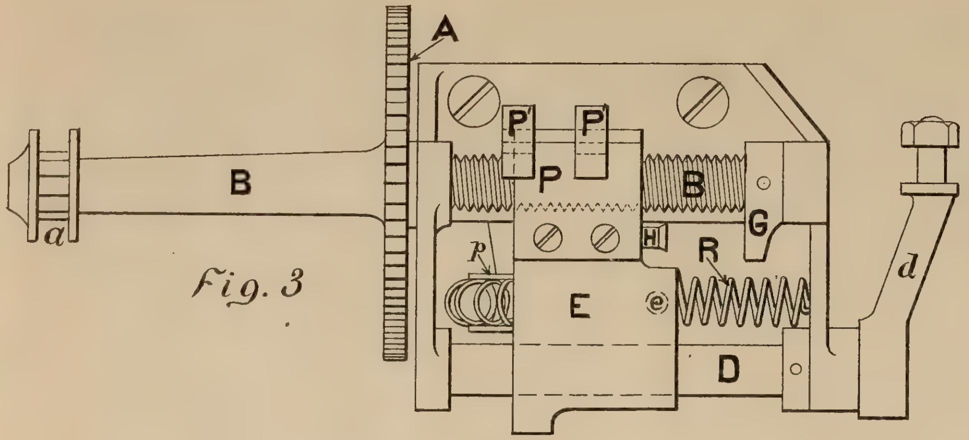


Fig. 3

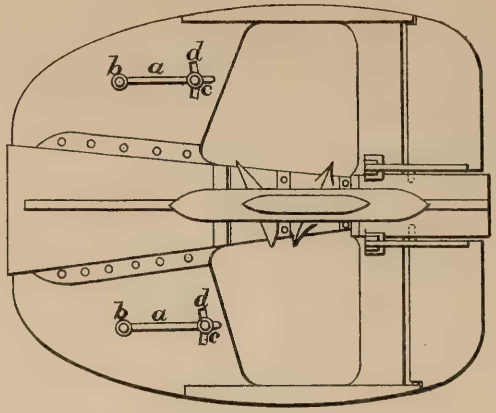


Fig 4

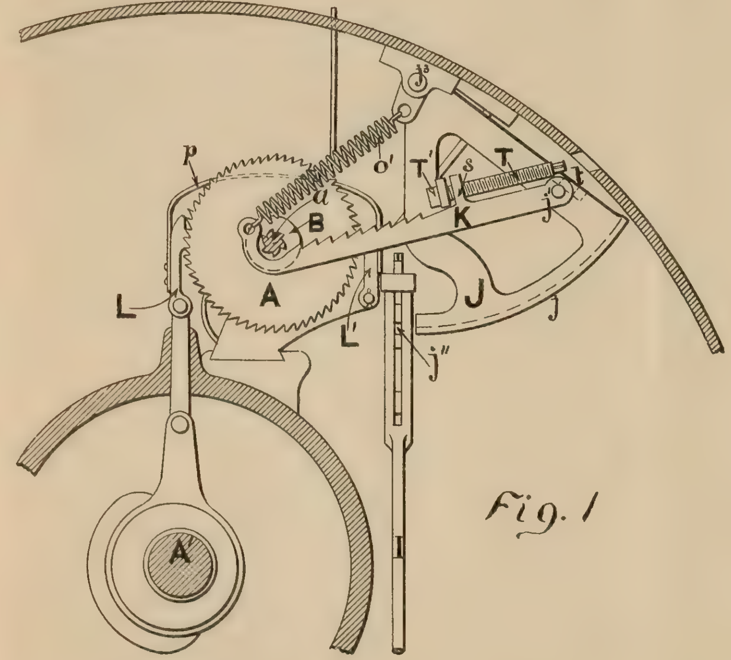


Fig. 1

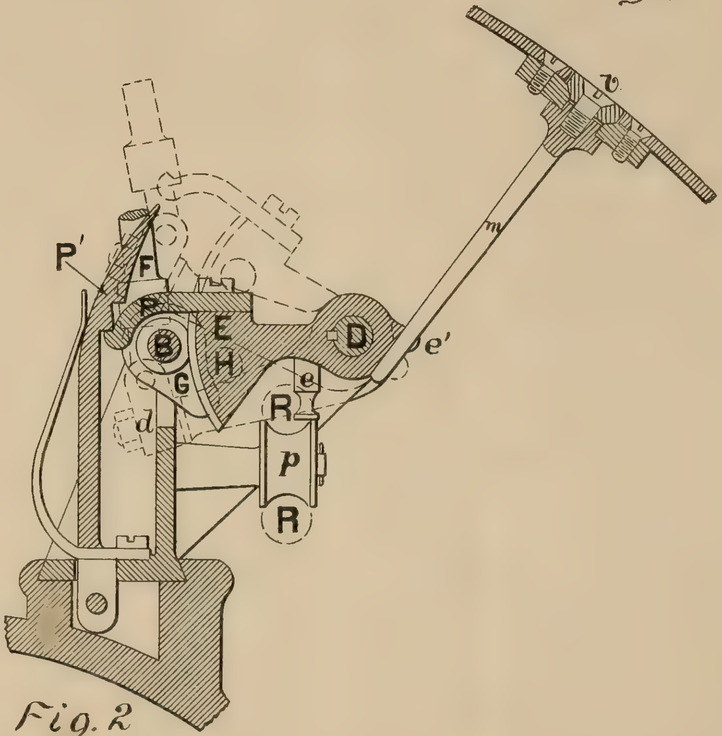


Fig. 2

PLATE VIII.

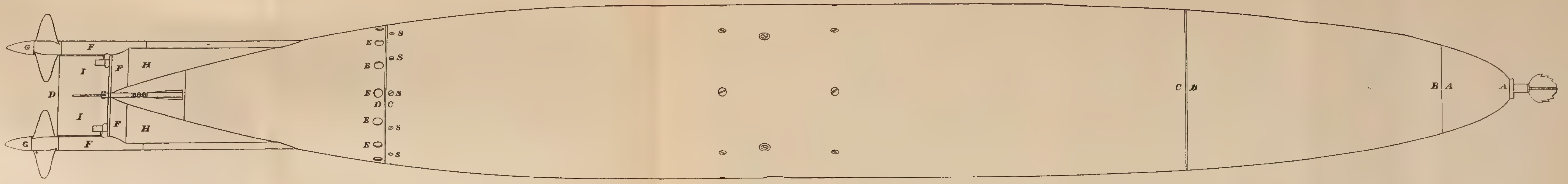


Fig. 1.

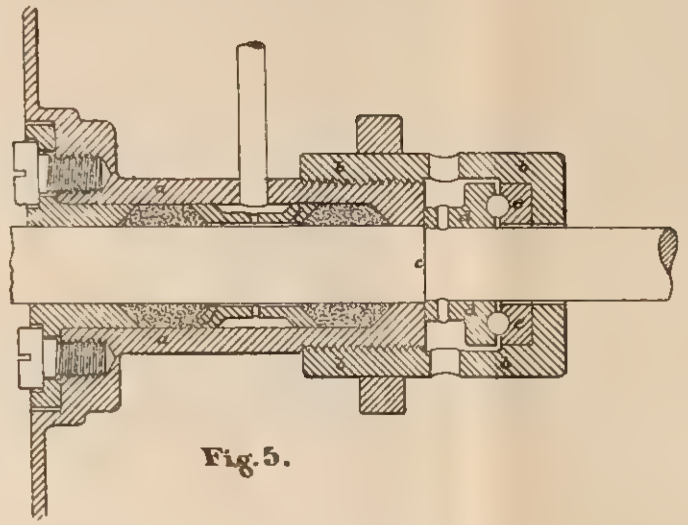


Fig. 5.

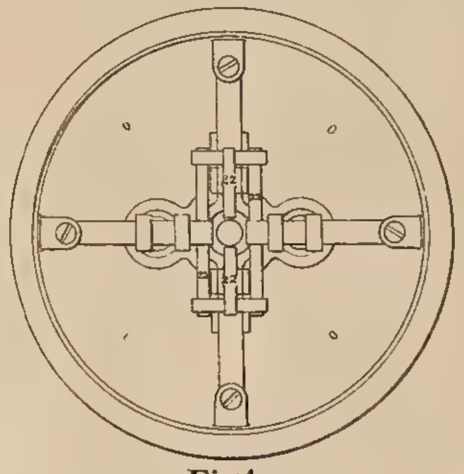


Fig. 4.

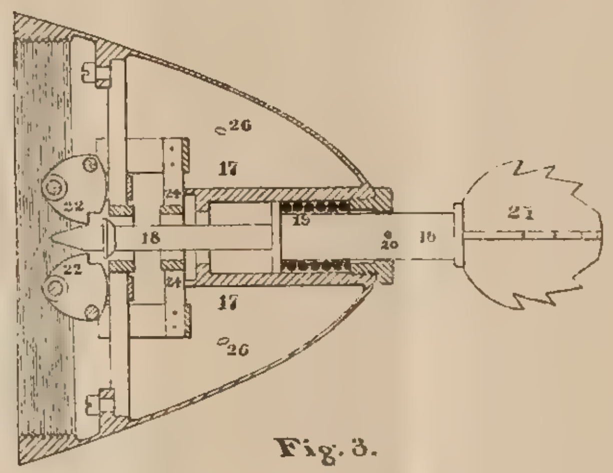


Fig. 3.

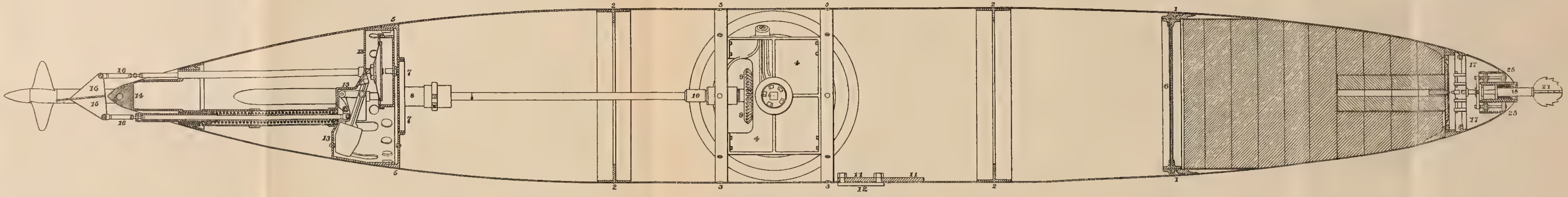
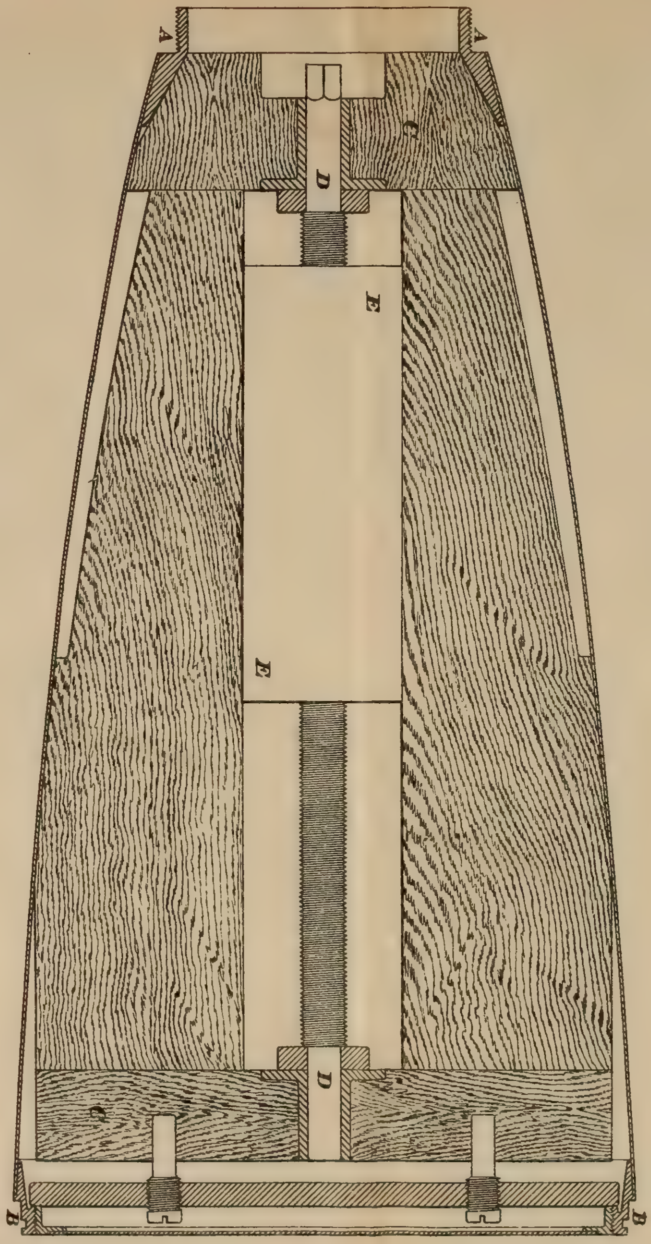


Fig. 2.

PLATE IX.



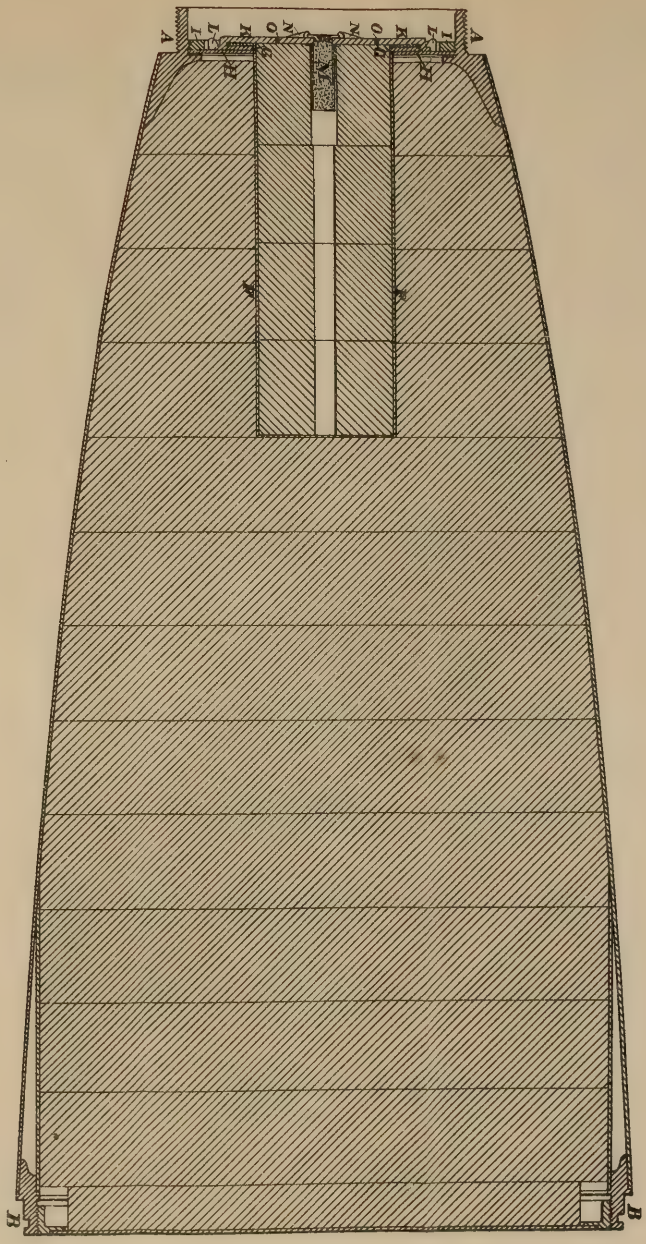
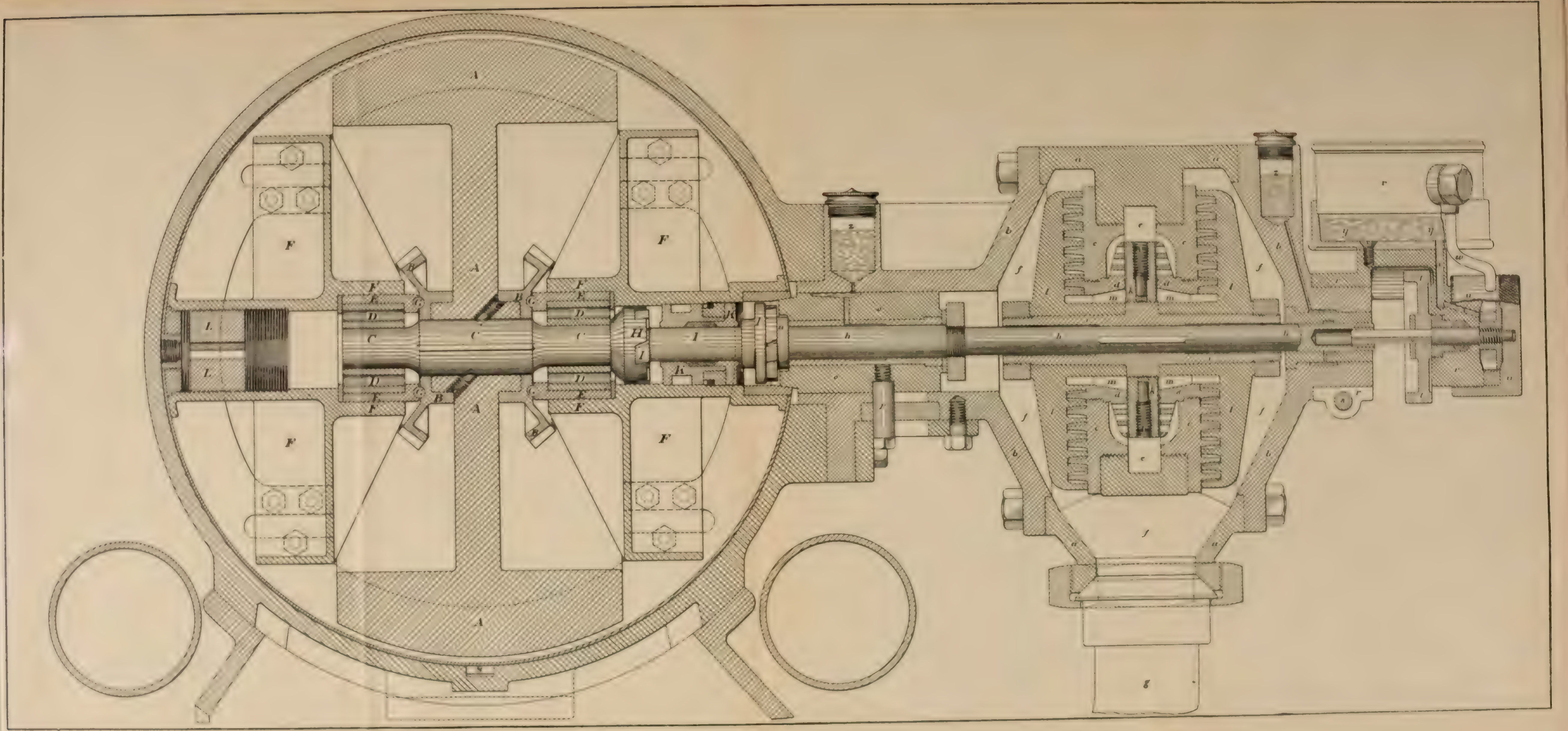
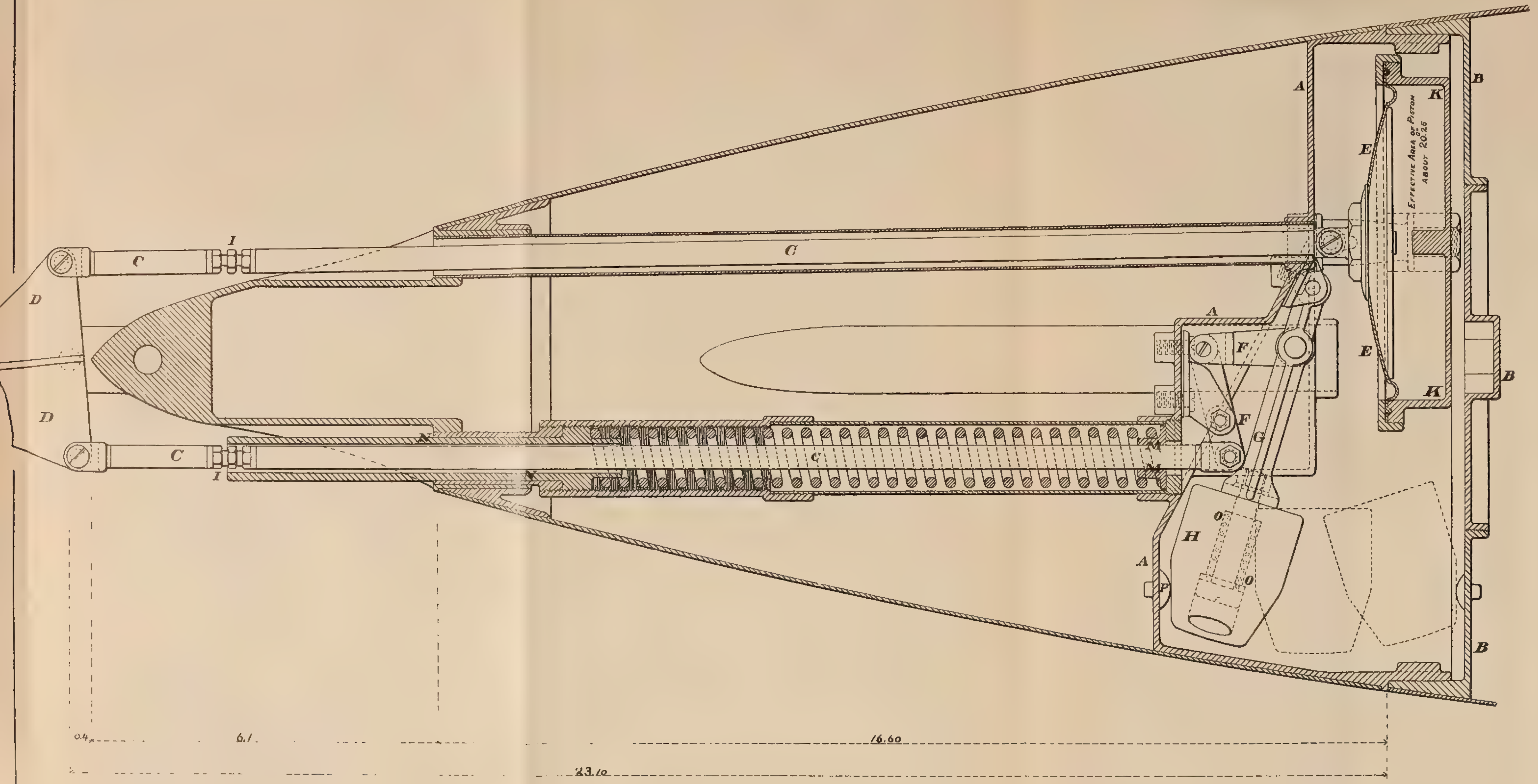


PLATE X

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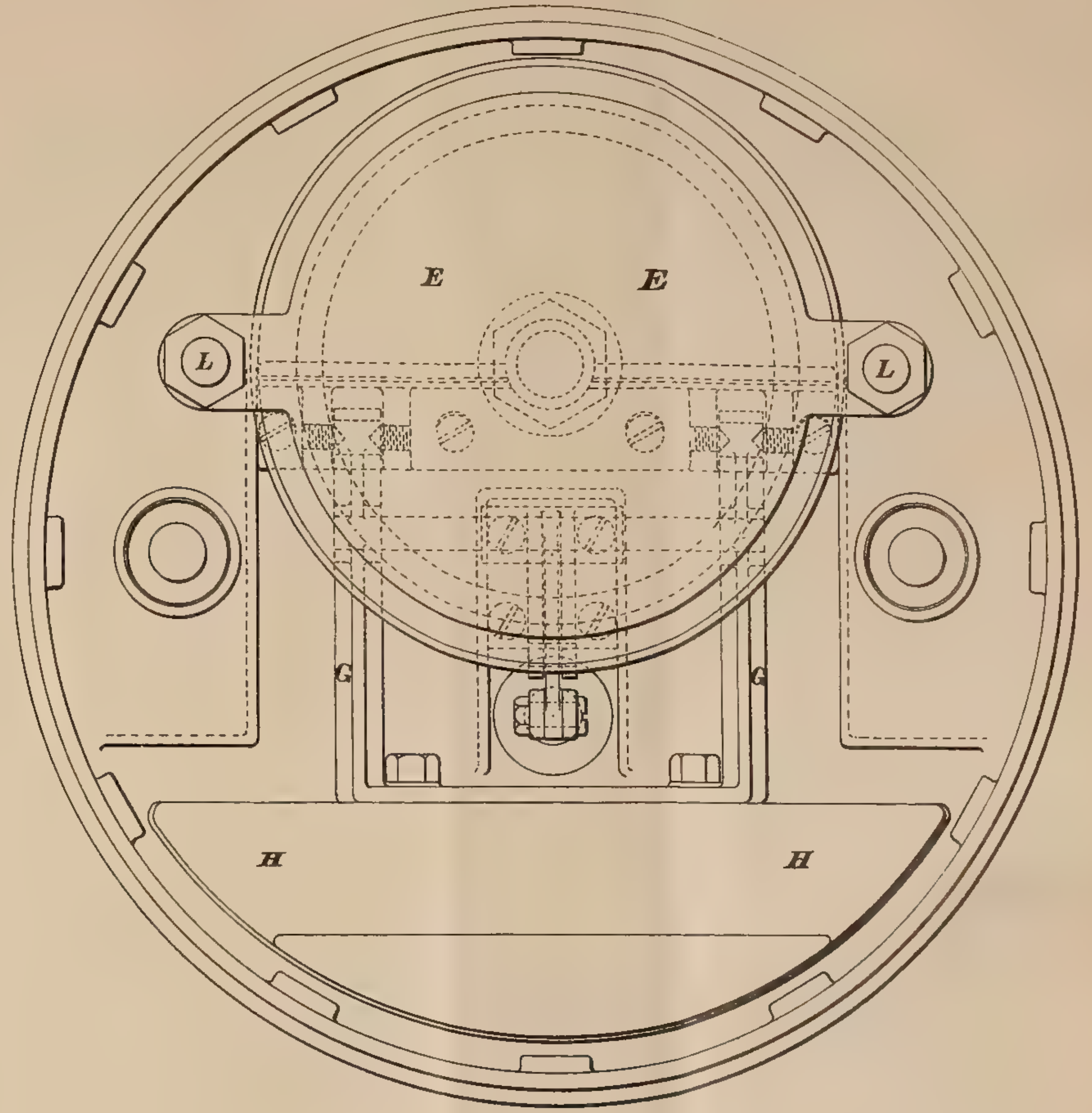
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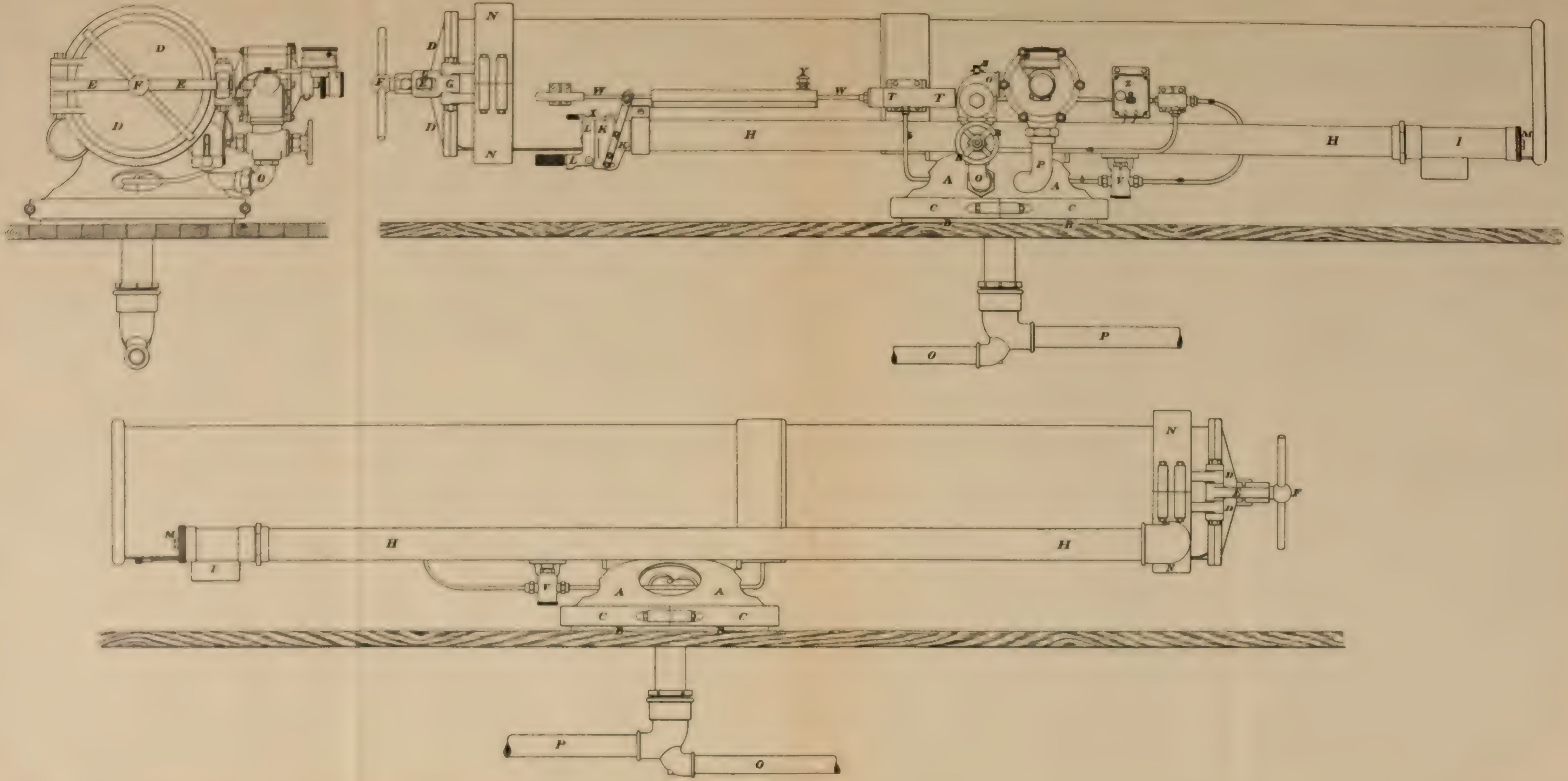

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